HABITAT MANAGEMENT PLAN FOR

BAYOU TECHE
NATIONAL WILDLIFE REFUGE

St. Mary Parish, Louisiana

Southeast Region

Bayou Teche National Wildlife Refuge

Habitat Management Plan

U.S. Department of the Interior
Fish and Wildlife Service
Southeast Region

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Executive Summary

The 9,028-acre Bayou Teche National Wildlife Refuge (NWR) is one of eight refuges in the Southeast Louisiana National Wildlife Refuge Complex (Complex) that encompass more than 160,000 acres of open and impounded marshes, maritime forests, hardwood bottomlands, pine flatwoods, barrier islands, rivers, bayous, and open waters. Thousands of waterfowl, as well as many species of shorebirds, wading birds, and songbirds, pass through the Complex each year. The Complex supports a diverse array of other wildlife, including threatened and endangered species. This Habitat Management Plan (HMP) provides a long-term vision and specific guidance for Bayou Teche NWR on managing habitat for its resources of concern for a 15-year time period. It is a step-down plan of the Comprehensive Conservation Plan for Bayou Teche National Wildlife Refuge (U.S. Fish and Wildlife Service 2009a).

Resources of concern are selected based on statutory requirements and reflect the highest priorities for refuge management, as outlined in the comprehensive conservation plan (CCP). The resource of concern for Bayou Teche NWR is the Louisiana black bear.

Goals and objectives must reflect refuge purposes with respect to the resources of concern. The following habitat management goals and objectives have been selected to support and add detail to goals and objectives in the CCP:

Goal 1. Restore and manage bottomland hardwood forests on Bayou Teche NWR to function as high-quality Louisiana black bear habitat.

Objective 1.1. Beginning by the year 2016, and every 3 to 4 years thereafter, approximately 1/3 of the 1,467 acres of operable bottomland hardwood forest on Bayou Teche NWR will be evaluated, and if necessary, will be treated silviculturally to produce the following conditions (LMVJV Forest Resource Conservation Working Group 2007):

- Overstory canopy cover 60 - 70 percent
- Midstory cover 25 - 40 percent
- Basal area 60 - 70 square feet/acre
- Tree stocking 60 - 70 percent
- >2 emergent canopy trees/acre
- Understory cover 25 - 40 percent
- At least 400 advance regeneration stems of shade-intolerant tree species (water oak, green ash, and sweetgum) over 30 - 40 percent of area
- ≥200 feet^3/acre of coarse (>10-inch diameter) woody debris
  4 visible small cavities/acre, or > 4 "snag" stems ≥ 4-inch dbh,
  or ≥ 2 stems > 20-inch dbh
- 1 visible large cavity/den tree/10 acres or ≥ 2 stems ≥ 26-inch dbh,
  (≥ 8 feet 2 BA ≥ 26-inch dbh)
- 6 "snag" or stressed tree stems/acre ≥ 10-inch dbh, or ≥ 2 stems ≥ 20-inch dbh,
  (> 4 fee t2 BA ≥ 10-inch dbh)

Objective 1.2. As lands become available, over the 15 years covered by this Habitat Management Plan, reforest cleared acreage by artificially regenerating appropriate hardwood species to recreate high-quality, diverse bottomland hardwood forest/bear habitat.

Goal 2. Manage cypress-tupelo swamp and associated marsh habitat on Bayou Teche NWR to provide high-quality swamp and marsh habitat for the Louisiana black bear and other trust species, and maintain biological integrity, diversity, and ecosystem health as swamp converts to marsh.

Objective 2.1. Every year, maintain populations of invasive plants on spoil banks, canals, and other habitats on Bayou Teche NWR at levels which do not impair habitat quality for the Louisiana black bear or other wildlife, and which do not interfere with human access or degrade aquatic habitat.

Goal 3. Wildlife habitats and the biological integrity, diversity, and ecosystem health of Bayou Teche NWR will be minimally affected by feral hogs, nutria, and other exotic animals.

Objective 3.1. Every year, maintain populations of feral hogs and nutria below levels at which they produce significant damage to bottomland hardwood forests, cypress-tupelo swamps, and marsh habitats.

The following strategies have been devised to best achieve the selected goals and objectives:

- Hardwood forest blocks in Franklin, Garden City, and North Bend East Units will be prioritized and cruised to assess timber volume and value and habitat parameters, including mast, cover, and den trees. Operability will be assessed based on soil type and road infrastructure.

- Forest management prescriptions will be written for each unit which will follow guidelines in LMVJV (2007) for bottomland hardwood forest desired conditions, with special emphasis on the Louisiana black bear.

- Chinese tallow will be controlled on spoil banks, roads, and light gaps in the forest canopy along canals in the Franklin, Garden City, North Bend East, North Bend West, Bayou Sale, and Centerville Units, by application of Garlon 4 as a basal spray in diesel, or by other herbicide treatment as approved. Treatment will be prioritized according to the importance of the habitat for the Louisiana black bear and the potential for releasing native vegetation valuable for bear habitat, including oaks and other mast-producing species.

- The refuge will work with partners (Louisiana State University, Louisiana Department of Wildlife and Fisheries) to release *Cyrtobagous salviniae* in salvinia-infested units of Bayou Teche NWR.

- Infestations of water hyacinth, Cuban sedge, and other aquatic weeds will be managed by herbicide treatment when they pose a threat to habitat or human use by preventing access.

- Conduct yearly evaluations of nutria and feral hog populations on refuge lands, using established monitoring protocols. Partner with area trappers to reduce nutria and feral hog populations.

- Participate in the State of Louisiana Nutria Control program by actively promoting the program and seeking assistance from area trappers to reduce nutria populations on refuge lands, consistent with the state's Nuisance Animal Control Plan.

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I. Introduction

For nearly 110 years, the National Wildlife Refuge System has played a crucial role in providing habitat for trust fish and wildlife species, natural laboratories for the advancement of the science of wildlife management, and places where the American public can go to hunt, fish, and learn about our nation's natural heritage. Now in the second decade of the Twenty-first Century, the role of national wildlife refuges is becoming increasingly important. Threats on an unprecedented scale, such as global climate change, exotic invasive species, and unsustainable land use, are causing irreversible changes to the natural systems on which we all depend. Properly managed conservation lands, scaled to the level of the threats they face, not only continue to serve their traditional purposes, but are also becoming increasingly essential to ensure the survival of natural systems and species, including our own. To meet these new challenges, managers will need to incorporate change and flexibility into land management plans. Adaptive management, "the rigorous application of management, research, and monitoring to gain information and experience necessary to assess and modify management activities" (602 FW 1), has been incorporated into Fish and Wildlife Service (Service) policy and will increase flexibility and effectiveness of management on Service lands.

VISION, SCOPE, AND RATIONALE

VISION

Bayou Teche National Wildlife Refuge is the only national wildlife refuge established primarily for the threatened Louisiana black bear. The refuge plays an integral role in its life cycle. Prime black bear habitat will be managed to provide a quality foraging and denning environment. Wildlife management strategies will include conservation of resident species and migratory birds. The refuge will play a critical role in coastal restoration efforts by cooperating with research agencies to aid in the understanding of coastal loss issues in south Louisiana. Visitors to the refuge will enjoy a quality outdoor experience centered on the traditional uses of hunting and fishing, while cultivating a conservation ethic that promotes stewardship of this important wildlife habitat.

SCOPE

This Habitat Management Plan (HMP) is a step-down plan of the Comprehensive Conservation Plan for Bayou Teche National Wildlife Refuge (U.S. Fish and Wildlife Service 2009a). Habitat management plans are dynamic working documents that provide refuge managers with a decision-making framework; guidance for the management of refuge habitat; and long-term vision, continuity, and consistency for habitat management on refuge lands. The HMP incorporates the role of refuge habitat in supporting conservation plans at local and regional scales, as well as plans focused on particular species and species groups. The goals and objectives contained in the HMP support the refuge vision and the wildlife and habitat management goals and objectives in the CCP for Bayou Teche NWR, which, in turn, reflect the information and recommendations in the Biological Review (U.S. Fish and Wildlife Service 2006), internal scoping within the Service, and information and recommendations gathered from the public and governmental partners during public scoping for the CCP. Finally, the HMP documents the analysis and selection of specific habitat management strategies to achieve those goals and objectives based on in-house data, published scientific literature, expert opinion, and staff expertise.

RATIONALE

Our reasons for writing this HMP are:

- Provide for long-term continuity of management direction;
- Describe desired future habitat conditions on the refuge;
- Document refuge management goals, objectives, strategies, and their rationale for interested members of the public;
- Ensure and facilitate compliance of refuge management actions with relevant policies and legal requirements;
- Document how the refuge will support larger scale conservation planning efforts by the Service and others;
- Create a reference and basis for prioritization of future operation, maintenance, and capital expense requests.

LEGAL MANDATES

The statutory authority for habitat management planning on refuges is derived from the National Wildlife Refuge System Administration Act of 1966, as amended by the National Wildlife Refuge System Improvement Act of 1997 (Improvement Act), 16 U.S.C. 668dd - 668ee. Section 4(a) (3) of the Improvement Act states: "With respect to the System, it is the policy of the United States that each refuge shall be managed to fulfill the mission of the System, as well as the specific purposes for which that refuge was established" and Section 4(a) (4) states: "In administering the System, the Secretary shall monitor the status and trends of fish, wildlife, and plants in each refuge." The Improvement Act provides the Service the authority to establish policies, regulations, and guidelines governing habitat management planning within the National Wildlife Refuge System (Refuge System). The Improvement Act prepared the way for a renewed vision for the future of the Refuge System where:

- Wildlife comes first;
- Refuges are anchors for biodiversity and ecosystem-level conservation;
- Lands and waters of the Refuge System are biologically healthy;
- Refuges are national and international leaders in habitat management and wildlife conservation;

Actions prescribed in habitat management plans comply with all applicable laws, regulations, and policies governing the management of the Refuge System. The lifespan of an HMP is 15 years and parallels that of refuge CCPs. HMPs are reviewed every 5 years by a peer review process, as appropriate, in the HMP revision process or when initiating refuge CCPs.

REFUGE PURPOSES

The purposes of a national wildlife refuge, as established by Congress or the Executive Branch, are the guidelines by which all objectives and actions on the refuge are measured. Habitat management, public use, and all other programs are required to fulfill the established purposes of the refuge. Legislative authority for the establishment and purpose of Bayou Teche NWR rests in the Endangered Species Act of 1973. The specified purpose of the refuge is: "to conserve (A) fish or wildlife which are listed as endangered species or threatened species" or (B) plants (16 U.S.C. 1534 (Endangered Species Act of 1973)." Bayou Teche NWR was established in 2001,

primarily to "conserve and manage habitat for the Louisiana black bear, a federally threatened subspecies of the American black bear" (U.S. Fish and Wildlife Service 2009a).

In addition to this specific purpose, the Improvement Act provides clear guidance for the mission of the Refuge System and priority wildlife-dependent public uses. The Improvement Act states that each refuge will:

- Fulfill the mission of the Refuge System;
- Fulfill the individual purposes of each refuge;
- Consider the needs of wildlife first;
- Fulfill requirements of comprehensive conservation plans that are prepared for each unit of the Refuge System;
- Maintain the biological integrity, diversity, and environmental health of the Refuge System; and
- Recognize that wildlife-dependent recreation activities, including hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation, are legitimate and priority public uses; and allow refuge managers authority to determine compatible public uses.

RELATIONSHIP TO OTHER PLANS

COMPREHENSIVE CONSERVATION PLAN

The CCP was finalized in 2009 and includes broad goals and objectives for management over a 15-year period. The purpose of this HMP is to provide more specific guidance that will facilitate the selection of prescriptions to implement the CCP goals and objectives.

LOUISIANA BLACK BEAR RECOVERY PLAN

The recovery plan for the Louisiana black bear (U.S. Fish and Wildlife Service 1995) listed five major goals for black bear management: (1) Preventing further habitat destruction; (2) establishing corridors between existing fragmented habitat; (3) integrating management among tracts to effectively use fragmented resources; (4) focusing efforts of a diverse user group toward common management objectives that benefit the bear; and (5) educating the public about the Louisiana black bear.

Delisting criteria (U.S. Fish and Wildlife Service 1995) for the Louisiana black bear are: (1) At least two viable subpopulations, one each in the Tensas and Atchafalaya River Basins; (2) immigration and emigration corridors between the two viable subpopulations; and (3) long-term protection of the habitat and interconnecting corridors that support each of the two viable subpopulations used as justification for delisting.

Actions prescribed in this HMP will support the goals and the delisting criteria described in the Louisiana black bear recovery plan. Bottomland hardwood habitat will be conserved and managed to provide year-round habitat for black bears. In addition, cypress-tupelo swamp on the refuge will be managed to provide high-quality bear habitat, including den trees.

BLACK BEAR RESTORATION PLAN

The Black Bear Conservation Committee produced a restoration plan for the Louisiana Black Bear (Black Bear Conservation Committee 1997). The goal of this plan is to "establish 5 bear subpopulations, each with a minimum of 200 adults to minimize the chance that the Louisiana black bear might become extinct." The plan includes a comprehensive set of conservation actions which, taken together, would greatly increase the probability of restoration of a healthy Louisiana black bear population. These actions include:

- Reducing human-caused mortality;
- Identifying occupied habitat;
- Establishing geographic management units based on locations of occupied habitat;
- Conducting research to develop habitat suitability index models and understand the genetics of Louisiana black bears;
- Identifying suitable, unoccupied habitat; and
- Restoring habitat that has become unsuitable.
- Actions detailed in this Habitat Management Plan contribute to the goal of the Black Bear Restoration Plan by conserving and restoring occupied habitat.

REGIONAL AND NATIONAL BIRD CONSERVATION PLANS

Many migratory and resident birds have habitat requirements which are complementary to those of the Louisiana black bear and which are met by Bayou Teche NWR, including large blocks of forest canopy, forested wetlands, the presence of mast-producing tree and shrub species, and low levels of human disturbance. Further, Bayou Tech NWR provides other habitat types used by birds, including shrub-dominated and herbaceous flotant wetlands. Bayou Tech NWR therefore contributes to the conservation goals of a number of large-scale bird conservation plans. Each of these will be briefly discussed below.

North American Bird Conservation Initiative

The North American Bird Conservation Initiative (North American Bird Conservation Initiative, U.S. Committee 2010) aims to ensure that populations and habitats of North America's birds are protected, restored, and enhanced through coordinated efforts at international, national, regional, and local levels, guided by sound science and effective management. It is designed to increase the effectiveness of existing and new initiatives through effective coordination, building on existing regional partnerships, and fostering greater cooperation among the nations and the peoples of the continent.

The North American Bird Conservation Initiative (NABCI) Committee is a forum of government agencies, private organizations, and bird initiatives helping partners across the continent meet their common bird conservation objectives. The committee's strategy is to foster coordination and collaboration on key issues of concern, including coordinated bird monitoring, conservation design, private land conservation, international conservation, and institutional support in state and federal agencies for integrated bird conservation. Four taxonomically delineated bird conservation planning initiatives fall under the auspices of NABCI: the North American Waterfowl Management Plan, the Partners in Flight North American Landbird Conservation Plan, the United States Shorebird Conservation Plan, and Waterbird Conservation for the Americas: the North American Colonial Waterbird Conservation Plan. Each of these initiatives

in turn has regional planning efforts which focus in more detail on individual Bird Conservation Regions (BCRs) (North American Bird Conservation Initiative, U.S. Committee 2010) or groups of BCRs. Bayou Teche NWR contributes to the goals of each of the relevant regional plans and of the NABCI by participating in the Gulf Coast Joint Venture (GCJV) and through the actions detailed in this plan.

North American Waterfowl Management Plan

The North American Waterfowl Management Plan (NAWMP Committee 2004) was signed by the United States and Canadian governments in 1986 and undertook an intensive effort to protect and restore North America's waterfowl populations and their habitats. When the plan was updated in 1994, Mexico became a signatory. The plan's main focus is restoration of wetlands and associated ecosystems in order to restore waterfowl populations to levels observed in the 1970s.

Regional partnerships called Joint Ventures composed of individuals; hunting and fishing groups; conservation organizations; and local, state, provincial, and federal governments were formed under the NAWMP. Bayou Teche NWR falls within the geographic area covered by the GCJV. The GCJV is divided geographically into six initiative areas, one of which is the Mississippi River Coastal Wetlands Initiative Area (MRCWIA) of southeastern Louisiana, which includes Bayou Teche NWR. The goal of the MRCWIA (Wilson et al. 2002) is to "provide wintering and migration habitat for significant numbers of dabbling ducks, diving ducks, and snow geese, as well as year-round habitat for the mottled duck."

Bayou Teche NWR will contribute to the goals of the NAWMP, GCJV, and MRCWIA by providing 9,028 acres of fresh marsh, cypress-tupelo swamp, and bottomland hardwoods to sustain resident and wintering waterfowl.

North American Waterbird Conservation Plan

The North American Waterbird Conservation Plan (Kushlan et al. 2002) was developed by Waterbird Conservation for the Americas, a group of individuals and organizations having interest and responsibility for conservation of waterbirds and their habitats in the Americas. Bayou Teche NWR is located in the Southeast U.S. Regional Waterbird Conservation Planning Area. A regional plan has been developed for the southeastern United States (Hunter et al. 2006). Marsh and cypress-tupelo habitat on Bayou Teche NWR support waterbirds year-round, and habitat requirements of waterbirds are complementary to those of the resources of concern for the refuge.

U.S. Shorebird Conservation Plan

The United States Shorebird Conservation Plan (Brown et al. 2001) is the product of a partnership involving organizations throughout the United States committed to the conservation of shorebirds. Bayou Teche NWR is located within the Lower Mississippi, Western Gulf Coast Shorebird Planning Region, for which a regional plan has been developed (Elliott and McKnight 2000). This plan divides the Gulf Coast Shorebird Planning Region into subregions. Bayou Teche NWR falls within the Mississippi River Coastal Wetlands subregion. Bayou Teche NWR contributes to the goals of the Lower Mississippi/Western Gulf Coast shorebird conservation plan by providing undisturbed foraging and roosting, non-beach habitat.

Partners in Flight Bird Conservation Plan

The National Fish and Wildlife Foundation led efforts in the 1990s to form the Partners in Flight program to combine resources and knowledge of many people to coordinate and plan landbird conservation in North America. Out of this effort came the Partners in Flight North American Landbird Conservation Plan (Rich et al. 2004) and a series of regional plans focused on BCRs, including the Gulf Coastal Prairie Region (Vermillion et al. 2008), which includes most of Bayou Teche NWR, and the Mississippi Alluvial Valley Region (Twedt et al. 1999), which includes the Centerville Unit. Bottomland hardwood and cypress-tupelo forests on Bayou Teche NWR provide important breeding, migrating, and wintering habitat for landbirds, whose habitat requirements are complementary to those of the resources of concern.

Louisiana Wildlife Action Plan

In December 2005, the LDWF released its Comprehensive Wildlife Conservation Strategy (Wildlife Action Plan) (Lester et al. 2005). The conservation actions and strategies in this plan were developed through public focus groups held across the state. Participants included invited conservation organizations, forestry and wildlife associations, federal and state agencies, industry, universities, and private citizens. The plan is meant to guide the conservation efforts of the LDWF through 2015.

This plan details the conservation needs and strategies for aquatic and terrestrial systems across the state, and lists a number of high-priority actions for imperiled species and systems. In the Mississippi River Alluvial Plain ecoregion, where Bayou Teche NWR is located, cypress-tupelo-blackgum swamp and bottomland hardwood forest are both listed as high priorities for conservation action, because of the severe threats they face and the number of species of concern that they support. Strategies described in Lester et al. (2005) to which management actions detailed in this HMP will contribute include:

Freshwater Marsh

- Shorebirds, Wading Birds
  - Continue to encourage the creation/enhancement/maintenance of high-quality habitat across Louisiana.

- Waterfowl
  - Work with DU, DW, and the Service to assure that quality habitat, including refuge from hunting and other disturbance, is distributed across the landscape.

Bottomland Hardwood Forest

- Promote use of appropriate silvicultural techniques to restore/manage bottomland hardwood forests for wildlife (include importance of tree species diversity), den trees for birds, mammals, etc.
- Encourage the use of Best Management Practices in the conservation of this habitat type.
- Work with Black Bear Conservation Committee, Louisiana Department of Transportation and Development, NRCS, USDA Forest Service, private landowners, the Service, and others to promote corridors of bottomland hardwood forests for wildlife species.

Cypress-Tupelo-Blackgum Swamps

Promote use of appropriate silvicultural techniques to restore/manage swamps for wildlife (include importance of tree species diversity, den trees for birds and mammals, etc.).

Regional Plans and Initiatives

As part of the Strategic Habitat Conservation (SHC) Initiative, the Service and U.S. Geological Survey (USGS) have identified twenty-two Landscape Conservation Cooperatives (LCCs) nationwide, including five in the Southeast: Appalachians, Gulf Coast Plain and Ozarks, Gulf Coast Prairie, Peninsular Florida, and South Atlantic. LCCs are conservation-science partnerships between the Service, the USGS, and other federal agencies, states, tribes, non-governmental organizations, universities, and stakeholders within a geographically defined area. They provide resource management decisions to address landscape-scale stressors, including habitat fragmentation, genetic isolation, spread of invasive species, and water scarcity, all of which are accelerated by climate change. LCCs provide scientific and technical support for conservation at "landscape" scales—the entire range of an identified priority species or groups of species. They support biological planning, conservation design, prioritizing and coordinating research, and designing species inventorying and monitoring programs. LCCs also have a role in helping partners identify common goals and priorities, resulting in more efficient and effective conservation. By functioning as network of interdependent units rather than independent entities, LCC partnerships can accomplish a conservation mission no single agency or organization can accomplish alone. The refuge falls mostly in the Gulf Coast Prairie LCC, with a small portion (Centerville Unit) in the Gulf Coastal Plains and Ozarks LCC. A development and operations plan was completed in December 2009 for the Gulf Coastal Plains and Ozarks LCC (U.S. Fish and Wildlife Service 2009c). The plan for the Gulf Coast Prairie LCC has not been completed at this writing (14DEC2011).

The Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA or Breaux Act) provides for targeted funds to be used for planning and implementing projects that create, protect, restore, and enhance wetlands in coastal Louisiana. Passed in 1990 and authorized until 2019, the federal funds created by this Act are managed by the CWPPRA Task Force, a group composed of five federal agencies, including the Service and the State of Louisiana. Coast 2050: Toward a Sustainable Coastal Louisiana was approved in 1998 by the State of Louisiana and its federal partners. Coast 2050 is a joint planning initiative among the Louisiana Wetland Conservation and Restoration Authority, Louisiana Department of Natural Resources Coastal Zone Management Authority, and the CWPPRA Task Force for protecting and sustaining the state's coastal resources for future generations in a manner consistent with the welfare of the people. In this plan, Bayou Teche NWR is located in Region 3 (Terrebonne, Atchafalaya, Teche/Vermilion). The plan emphasizes that immediate attention should be placed in the Barataria Basin with ecosystem strategies to restore swamps, restore and sustain marshes, protect bay/lake shorelines, and restore barrier islands and Gulf shorelines.
In 1989, the Louisiana Legislature passed Act 6 (LA R.S. 49:213.1 et seq. of the Second Extraordinary Session of the Legislature) recognizing the catastrophic nature of Louisiana's coastal land loss and expanded the state's capacity to respond to the crisis by creating the Wetlands Conservation and Restoration Authority (State Wetlands Authority); the Wetlands Conservation and Restoration Fund (the Fund); the Governor's Office of Coastal Activities (GOCA); and the Office of Coastal Restoration and Management. The State Wetlands Authority is a policy level decision-making group made up of the Governor's Executive Assistant for Coastal Activities, the Commissioner of the Division of Administration, and the secretaries of five

state agencies - the Department of Wildlife and Fisheries, Environmental Quality, Natural Resources, Transportation and Development, and Agriculture and Forestry. The State Wetlands Authority is the sponsor and official author of the State Plan, an annual summary of coastal restoration projects and recommendations for funding from the Fund. The Fund's income is from a portion of the state's mineral income and severance taxes from oil and gas production on state lands and is dedicated to state sponsored coastal restoration projects. The GOCA coordinates policy among the many agencies involved in Louisiana's coastal restoration effort while the Office of Coastal Restoration and Management within DNR handles day-to-day implementation of coastal restoration in coordination with the Coastal Zone Management Office.

II. Background, Inventory, And Habitat Descriptions

Bayou Teche NWR is a 9,028-acre refuge situated along and on either side of Bayou Teche, which is an ancient channel of the Mississippi River. It consists mostly of back-swamp land off of the natural levees of the bayou, which are mostly cleared and farmed. Habitats on the refuge include bottomland hardwood forests, cypress-tupelo swamps, and freshwater marshes.

LOCATION

Located in Saint Mary Parish near the city of Franklin, Louisiana, Bayou Teche NWR is 45 miles southeast of Lafayette, 53 miles south-southwest of Baton Rouge, and 86 miles west-southwest of New Orleans, Louisiana. The refuge is one of eight administered out of the Southeast Louisiana National Wildlife Refuge, with an office in Lacombe, Louisiana (Figure 1).

MANAGEMENT UNITS

The refuge consists of 6 noncontiguous management units, ranging in size from 81 acres to 3,619 acres. The current approved acquisition boundary covers 36,657 acres (Figure 2). A short description of each unit is given in Table 1.

Figure 1. Location of Bayou Teche NWR in southeastern Louisiana

Figure 2. Bayou Teche NWR management units
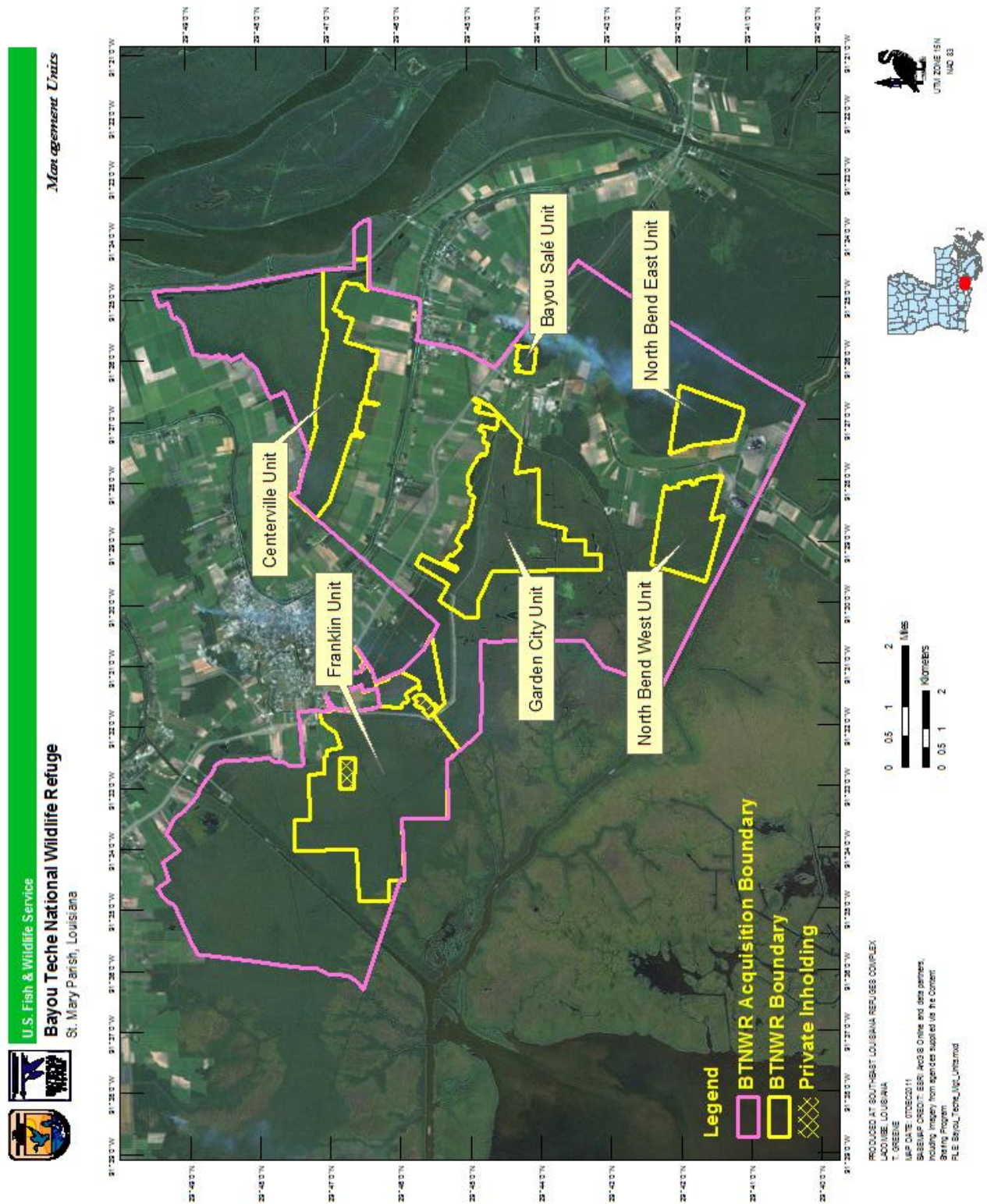
Table 1. Management unit descriptions for Bayou Teche NWR in St. Mary Parish, Louisiana

Unit	Size (acres)*	Description
Franklin	3,619	Unit consists mostly of cypress-tupelo swamp with a smaller area of bottomland hardwoods on the east side of the levee which bisects the unit. Also included in the southern end of the unit is an area of freshwater marsh. Access to the western portion of the unit is by boat through a system of canals. Portions of the eastern side of the unit are accessible through roads. Landscape context of this unit is good, with natural habitats on three sides. Bear activity has been detected in this unit, although habitat is mostly restricted to spoil banks on the canals, and quality is low.
Centerville	1,587	The Centerville unit consists almost entirely of cypress-tupelo swamp except for a small area of planted bottomland hardwood forest along the southern edge. This unit is the southern ~40 percent of a block of natural habitat (cypress-tupelo swamp), which is surrounded on two sides by agricultural fields and on the third by Bayou Teche, but cut off from the bayou by a levee.
Garden City	2,319	Most of this unit is cypress-tupelo swamp, with a smaller area of bottomland hardwood forest to the north. Small inclusions of shrubby marsh are mapped in the southern portion of the unit. The unit is bisected by a canal which is not owned by the refuge. This unit is heavily dissected by canals, but is surrounded on two sides by swamp. Agricultural fields lie to the north. Bottomland hardwood forest on this unit is second-growth, high-graded timber dominated by water oak, sweetgum, American elm, and sugarberry.
Bayou Salé	81	The Bayou Salé unit consists of bottomland hardwood forest blocks fragmented by pipeline and power line rights-of-way and a road. This unit is approximately half of a heavily dissected block of forest surrounded by agricultural fields, except for a narrow connection to a large block of forest to the southeast.

Unit	Size (acres)*	Description
North Bend West	921	This unit is mostly cypress-tupelo swamp (718 acres), with inclusions of shrubby marsh in the interior and herbaceous marsh on the west side. A small area (47 acres) of naturally regenerated bottomland hardwoods lies on the east side, across a dirt road/right-of-way. Landscape context for this unit is good, with agricultural fields on the east side and marsh to the west. This unit appears to be converting to freshwater marsh, dominated by cattails (*Typha spp.*) and cutgrass (*Zizaniopsis miliacea*). Baldcypress trees in the unit appear to be decadent, and 25-50 percent of the standing trees in the unit are dead. Herbaceous emergent vegetation cover is near 100 percent.
North Bend East	553	The North Bend East unit consists of naturally regenerated bottomland hardwood habitat, bisected by one open right-of-way. This unit is a small portion of a large block of bottomland hardwood habitat to the east. This unit is reasonably high-quality bear habitat, and together with the adjacent private lands provides a large area of usable black bear habitat.

PHYSICAL FEATURES

CLIMATE

Climate in this region is subtropical with mild winters and warm, humid summers. Precipitation during the summer months is mostly associated with thunderstorms, and is typically intense and of short duration. During the cool season, precipitation is mostly caused by frontal passage, and is typically less intense and of longer duration. Freezes are generally mild and of short duration. Frost-free (i.e., ≥ 32oF) period 5 years out of 10 is 345 days; 2 years out of 10 it is 365 days (Natural Resources Conservation Service, n.d.).

Precipitation

Annual precipitation at Bayou Teche NWR averages 64.4 inches and falls almost exclusively as rain. Rainfall peaks during the summer months, when frequent, sometimes intense, thunderstorms raise monthly totals above 7 inches. Monthly totals during the fall and spring are generally below 5 inches, with April being the driest month (Figure 3) (NOAA 2011). From November to February, the weather patterns are influenced by cold continental air masses. Rainfall during this period comes mostly from the effects of frontal passages. Rain events are more widespread and less intense than those in the summer. Tropical storms impact the Louisiana coast every 1.6 years, and hurricanes every 3.3 years (Roth 1988). Areas in the path of one of these storms can receive significant rainfall in addition to wind and storm surge.

Temperature

Air temperatures at Bayou Teche NWR are moderated by the Gulf of Mexico, which buffers the temperature extremes associated with continental air masses. Normal temperature maxima for January and July, respectively, at Franklin, Louisiana, are 62oF and 89oF; minima are 43oF and 74oF (NOAA 2011). On average, temperature falls below freezing 11 days each year, mostly in December and January. Freezing conditions only occurred November through March during the 30-year period from 1981-2010. Mean and monthly average temperature maxima and minima are presented in Figure 4.

Tropical Cyclones

Named tropical storms (i.e. storms with sustained winds at least 35 knots (64.8 km/h)) impact southeastern Louisiana on average 3 or 4 times per decade (Global Security.org, 2005). Tropical cyclones are an important feature of the climate of southern Louisiana. These storms have shaped the landscape, vegetation, and ecology of the area for millennia, and continue to do so today. Storm surges can completely reshape coastal landforms, and periodic inundation with saltwater restricts the range of vegetation types that can occupy an area. High winds associated with these storms also affect growth forms of woody vegetation, favoring windfirm species like baldcypress and longleaf pine, and those with above-ground growth forms that are resistant to wind, like live oak, and providing disturbance which increases biodiversity (Merry et al. 2009, Mitchell and Duncan 2009).

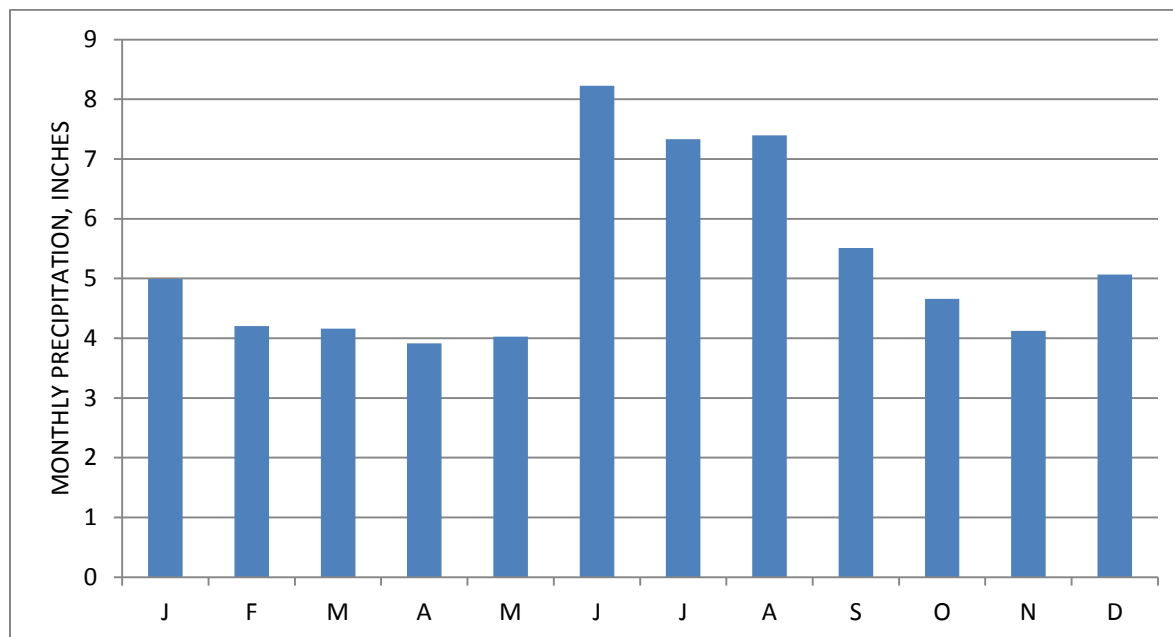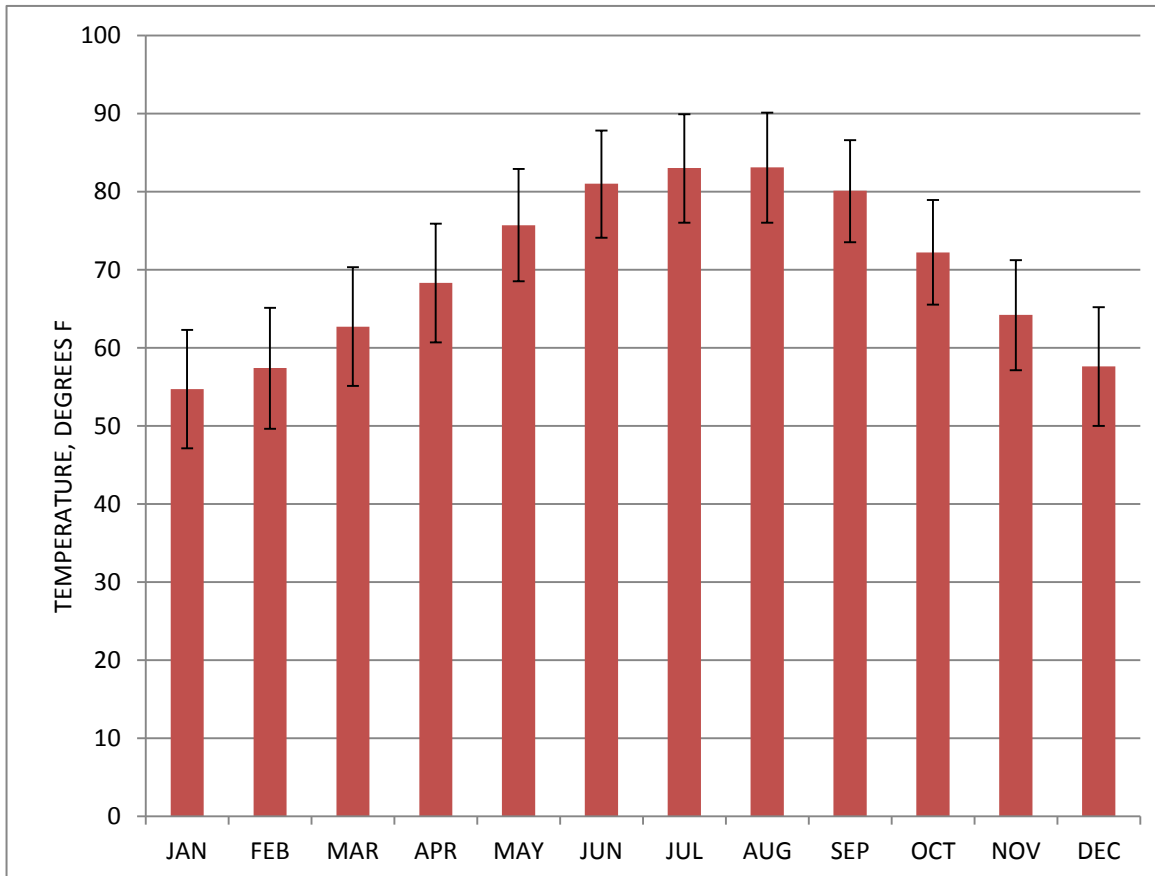**Figure 3. Mean monthly precipitation, Franklin, Louisiana, 1981-2010**

Figure 4. Mean temperature, degrees Fahrenheit, with average daily minima and maxima, by month at Franklin, LA, 1981-2010 (NOAA 2011)

Bayou Teche NWR is within 12 miles of the coast, and elevations on the refuge range from 0-5 feet above msl. Most of the refuge is subject to inundation in even moderate storm surges, and large storms, most recently Hurricane Rita in 2005, have pushed water up canals and inundated areas behind flood protection levees. High winds and rain associated with tropical cyclones can be expected as well. Intensification of tropical cyclones associated with global climate change will increase the effects they have on the refuge.

GEOLOGY AND TOPOGRAPHY

Bayou Teche is an ancient outlet of the Mississippi River, and the entire area surrounding the refuge is on alluvial deposits. High ground in the vicinity of the refuge is mostly on natural levees of bayous, while land away from waterways is low-lying and poorly drained. Essentially all reasonably well-drained soils in St. Mary Parish are cleared and in sugarcane cultivation or urban use, with the exception of some recently reforested former cane fields slated for wetland mitigation banking.

HYDROLOGY

The hydrology of Bayou Teche NWR and the surrounding area has been modified significantly from pre-settlement conditions by the construction of levees and canals, and by the combined effects of coastal subsidence and global sea-level rise. A system of levees and pumps, constructed to protect agricultural fields from storm surge, maintains drier-than-natural conditions inside and wetter-than-natural conditions outside of the protected areas. Portions of Bayou Teche NWR which lie inside the levee system support bottomland hardwood forest, while areas outside the levee system are cypress-tupelo swamps or freshwater marsh. None of the water management infrastructure is under the control of refuge managers.

SOILS

Soils on Bayou Teche NWR are predominantly mucks and clays, and are all subject to at least occasional flooding. Outside the levee protection system, Maurepas muck predominates, while higher ground within the levee protection zone are a mix of mucks and clays, which support bottomland hardwoods under the present artificial drainage regime. Detailed soil information is presented in Appendix E.

ECOSYSTEM CONTEXT

Bayou Teche NWR lies to the west of the Atchafalaya basin, mostly outside the West Atchafalaya Protection Levee, and mostly within 12 miles of the Gulf coast. The refuge protects some remnant bottomland hardwood stands, as well as large areas of cypress-tupelo swamp. Essentially all non-urban, arable acreage in St. Mary Parish is under sugarcane cultivation. Farm land in the parish is restricted to natural levees of watercourses, including Bayou Teche and its distributaries. Land that is inside the levee protection area and in timber is generally too low and wet for cultivation, and is used for recreational hunting and timber production. Land outside the levee protection system is lower, wetter, and generally dominated by cypress-tupelo swamps and marshes.

Critical habitat for Louisiana black bear has been designated along the Louisiana coast from Avery Island to Morgan City, including all units of Bayou Teche NWR except Centerville. Protected lands nearby mostly consist of wildlife management areas managed by LDWF and easements held by the U.S. Army Corps of Engineers (USACE) (Figure 5).

HISTORICAL CONDITION OF REFUGE HABITATS

Before European settlement, the area that would become Bayou Teche NWR was dominated by cypress-tupelo swamp and bottomland hardwoods. Bayou Teche flowed southeast and drained into Vermillion Bay, West Cote Blanche Bay, East Cote Blanche Bay, and Atchafalaya Bay through a series of distributaries. Seasonal flooding and periodic inundation by storm surges from tropical cyclones would have been the major ecosystem drivers, and elevation the critical variable determining vegetation type. Major disturbances would have included windthrow from tropical cyclone winds and tornadoes and salt deposition from storm surge inundation. Natural levees of Bayou Teche and its distributaries where flooding would have been less frequent and of shorter duration supported bottomland hardwoods, while back swamps were dominated by baldcypress and tupelogum. Closer to the Gulf, marsh vegetation types would have covered the most low-lying areas, as they do now. Fire return intervals in marsh are debated, but fire would have been relatively frequent there, and much less frequent in the forested areas, especially the baldcypress-tupelogum swamps.

CURRENT HABITAT CONDITIONS

VEGETATION TYPES

Bayou Teche NWR supports three general vegetation types, listed in Table 2 and Figure 6. Although formal characterization of the vegetation types on the refuge has not been conducted, it appears that these three types, baldcypress-tupelo swamp, bottomland hardwood forest, and fresh shrub/flotant marsh, correspond, at least in part, to the following International Vegetation Classification System (IVCS) Alliances. Intersecting or corresponding SAF Forest Types (Eyre 1980) are given for reference when applicable.

Fraxinus pennsylvanica – Ulmus americana – Celtis laevigata/Ilex decidua Forest (CEGL002427)

Alluvial forests in this association are dominated by green ash, American elm, and sugarberry, and fall under the *Acer saccharinum – Fraxinus pennsylvanica – Platanus occidentalis* Floodplain Group. The type occurs on alluvial soils which are dry for most of the growing season. Common canopy associates are overcup oak (*Quercus lyrata*), water hickory (*Carya aquatica*), sweetgum (*Liquidambar styraciflua*), and boxelder (*Acer negundo*). Shrubs include swamp dogwood (*Cornus drummondii*) and deciduous holly (*Ilex decidua*). Also common in this forest association are lianas, especially poison ivy (*Toxicodendron radicans*), trumpet creeper (*Campsis radicans*), and Virginia creeper (*Parthenocissus quinquefolia*) (NatureServe 2011). Although most of the bottomland hardwood forest on Bayou Teche NWR appears to map more or less closely to this association, they also have a component of water oak (*Quercus nigra*) and red maple (*Acer rubrum*). Forests on the refuge exhibit signs of previous high-grading and commercially valuable species (green ash, water oak) are probably at lower densities than they would otherwise be. The association intersects with the SAF forest type Sugarberry – American Elm – Green Ash: 93 (Eyre 1980).

Figure 5. Protected lands and critical habitat for Louisiana black bear in the vicinity of Bayou Teche NWR
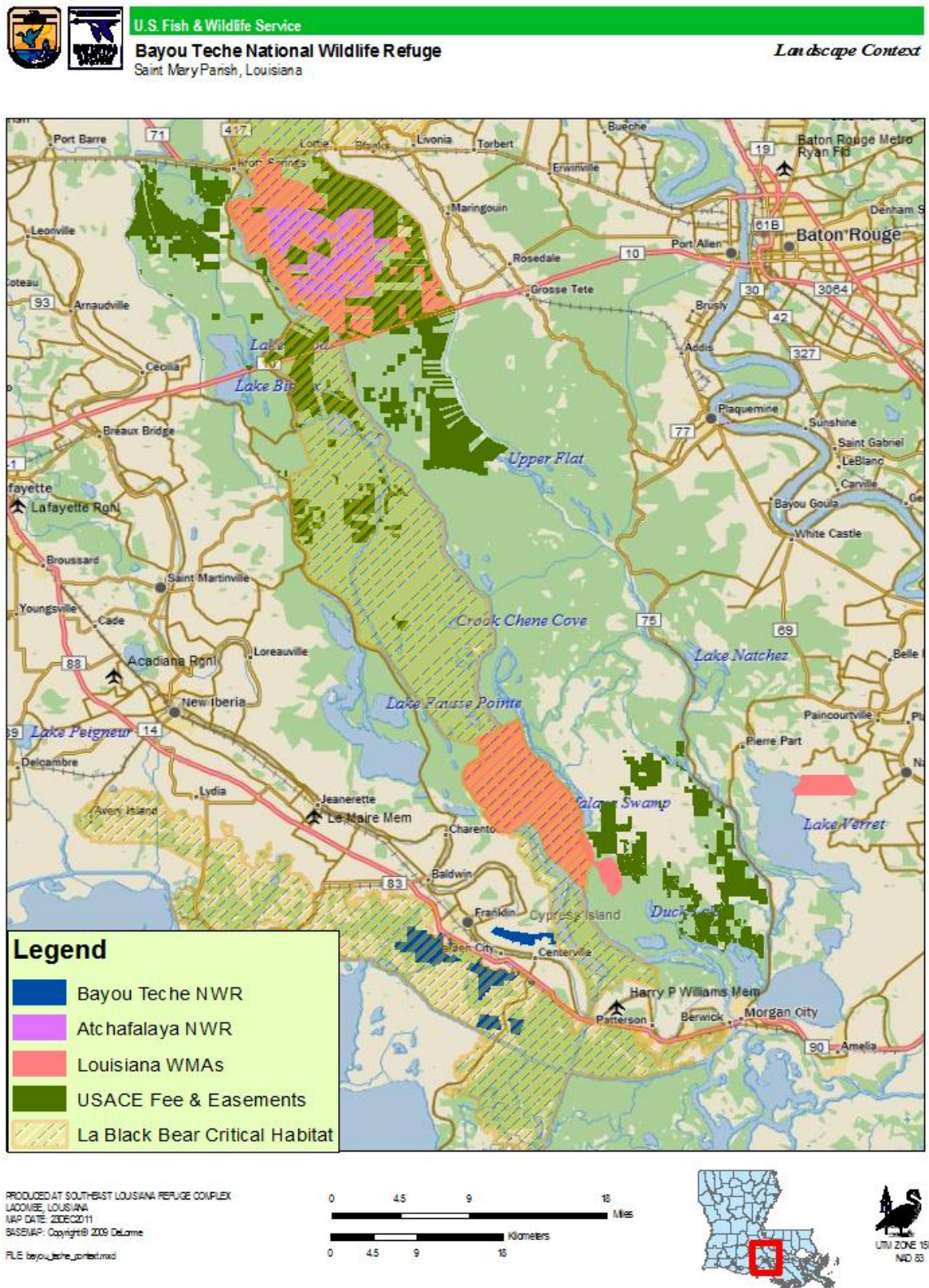
Figure 6. General habitat types on Bayou Teche NWR
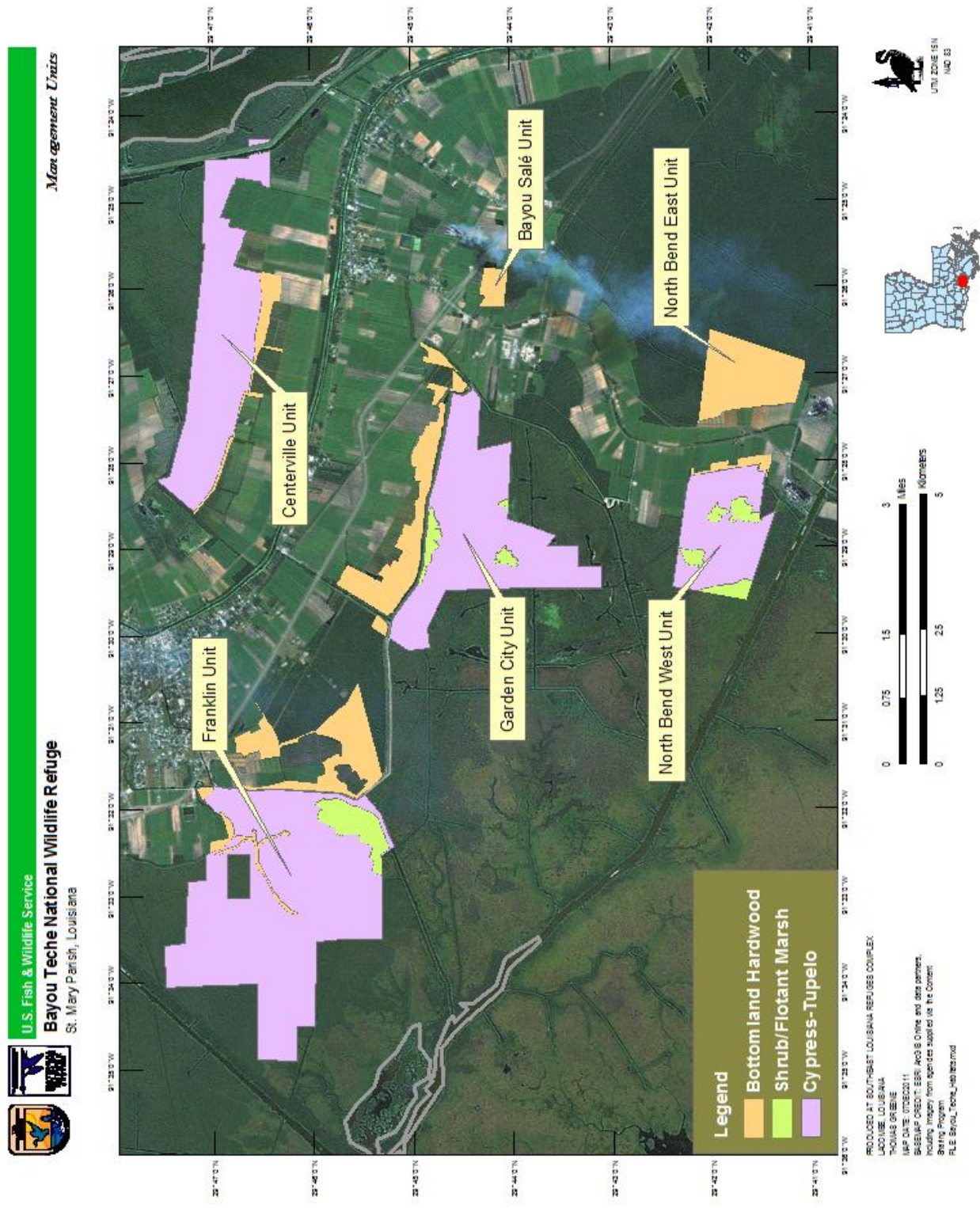
Table 2. Habitat types and associated acreages* found on Bayou Teche NWR

Habitat Type	Acres	Management Units	Habitat Conditions
Freshwater marsh/wetland scrub-shrub	186	Franklin	Healthy habitat type, dominated by cutgrass with an increasing amount of cattails in the North Bend West unit. Flotant components of this habitat are in competition with a variety of invasive species, including water hyacinth, giant and common salvinia, and Cuban sedge.
	71	Garden City	Shrub component is mostly waxmyrtle.
	128	North Bend West	Shrub component is mostly waxmyrtle.
Cypress-Tupelo Swamp	1491	Centerville	Stable in some areas but overall cypress tupelo stands in Garden City, Franklin Unit, and North Bend West Units (outside of levee protection) are thinning and regeneration is poor. Stands are increasingly composed of snags from remnant cypress/gum. Den trees are rare.
	2926	Franklin	
	1590	Garden City	
	718	North Bend West	
Bottomland hardwoods including spoil bank areas	74	Bayou Salé	Bottomland stands are maturing, though still showing the effects of previous timber management. Bottomland hardwoods that remain outside of levee protection (spoil banks and location roads) are sparse and in competition with invasive species, particularly Chinese tallow. Den trees are rare. Hard mast production is mediocre.
	125	Centerville	
	510	Franklin	Approximately 437 acres are operable
	502	Garden City	
	533	North Bend East	
	47	North Bend West	

* Acreages were calculated using ARC-GIS (ESRI 2009), and thus are approximate.

Taxodium distichum – (Nyssa aquatica)/Forestiera acuminata – Planera aquatica Forest (CEGL002421)

This association is classified under the *Taxodium distichum – Nyssa aquatica* Floodplain Forest Group. At this writing, alliances are "under review" (NatureServe 2011). This association includes baldcypress-water tupelo forests in the Mississippi River Alluvial Plain and adjacent portions of the Gulf Coastal Plain. Swamp forests in this association are dominated by baldcypress and water tupelo. Other trees which may be present include water hickory (*Carya aquatica*) and overcup oak (*Quercus lyrata*). Shrubs can include buttonbush (*Cephalanthus occidentalis*), Virginia-willow (*Itea virginica*), and red maple (*Acer rubrum*), among others (NatureServe 2011). On Bayou Teche NWR, these forests occur mostly outside the levee-protected areas, and water levels in them are tidally influenced. This association is related to SAF Forest type #102, Baldcypress – Tupelo (Eyre 1980).

Typha domingensis – Seasonally Flooded Gulf Coastal Plain Herbaceous Vegetation (CEGL004137)

This association is classified under the Macrogroup Atlantic and Gulf Coastal Plain Pondshore and Wet Meadow, and the *Rhynchospora* spp. – *Eleocharis* spp. – *Xyris* spp. Wet Prairie Group. At this writing, alliances are "under review" (NatureServe 2011). At least portions of the fresh marsh on Bayou Teche NWR are dominated by *Typha domingensis.* Other types of fresh marsh and wetland scrub-shrub habitat have not been mapped by IVCS association, but probably exist on the refuge.

HABITAT CHANGES FROM HISTORIC TO CURRENT CONDITION

Environments and ecosystems are in a constant state of flux, never truly reaching equilibrium. Stasis, whether defined in terms of some ideal past or desired future conditions, is not an option. Healthy ecosystems are ones in which robust ecosystem processes catalyze change at multiple scales in response to environmental shifts, without catastrophic losses of biodiversity or major functions. In today's highly modified landscapes, large-scale natural processes have been disrupted, leading to loss of ecosystem health and resiliency. Refuge managers must strive to restore or mimic (i.e., either recreate on a small scale or reproduce the important process components through management inputs) ecosystem processes in order to maintain biological integrity, diversity, and environmental health and maintain habitat conditions favorable for the resources of concern. Often, this means active management (e.g., water management, prescribed fire, forest management, control of exotic invasive organisms) is required. Strategies such as these are generally most successful when conducted in the context of maintaining or restoring ecosystem processes.

Changes in habitats from historic to present on Bayou Teche NWR and in St. Mary Parish are mostly anthropogenic, although natural subsidence of the Louisiana coast (NASA 2008; Shinkle and Dokka 2004) contributes to the conversion of drier to wetter types over time. Anthropogenic forces which have altered habitats over the past two centuries include modification of hydrology and drainage patterns, clearing of land for agriculture and urban

uses, forest resource extraction, and increasingly, climate change. Habitat changes that have resulted from these activities include the following:

- Loss of most of the bottomland hardwood forest habitat in the region;
- Degradation of the remaining bottomland hardwood forest, including decreased cover of important mast-producing species;
- Fragmentation of forest habitat and loss of travel corridors between blocks;
- Conversion of swamp to marsh due to hydrologic changes, subsidence, and sea level rise;
- Conversion of swamp to bottomland hardwood forest due to levee protection;
- Presence of spoil banks and canals, which provide both deepwater habitat as well as elevated areas within swamps where bottomland hardwood species can grow.
- Each of these changes will be discussed in more detail below.

LOSS OF BOTTOMLAND HARDWOOD FOREST HABITAT

The natural levees of Bayou Teche and its distributaries once supported continuous bottomland hardwood forests. Higher sites near the watercourses would have been vegetated with drier-type forests, dominated by oaks, while wetter areas would have been dominated by green ash – American elm – sugarberry forest, as the remnants are today. Most of this land, because it is valuable as farmland, was cleared during colonial times in the 18th and early 19th Centuries for sugar production, which use continues today.

FOREST HABITAT DEGRADATION

Remnant patches of bottomland hardwood forest on Bayou Teche NWR are mostly dominated by green ash – American elm – sugarberry second-growth forest. These forests show signs of high-grading, as do most such forests in the MAV. Commercially valuable species, in this case water oak and green ash, are rarer than they otherwise would be, and those that remain are often crooked, hollow, or otherwise of low grade. Although producing timber is not an objective of the refuge, mast production from thrifty, productive water oaks would increase the value of the habitat for Louisiana black bear, and higher commercial timber value would increase the number of options available to habitat managers.

Baldcypress – tupelogum swamps on the refuge consist of second-growth forests which regenerated after wholesale extraction of cypress during the late 19th and early 20th Centuries. Some areas of the refuge have regenerated to baldcypress – tupelogum swamp, while others are dominated by herbaceous vegetation with relict (cull) cypress trees remaining (Franklin Unit). It is not clear whether these areas will ever regenerate to baldcypress – tupelogum swamp, given changes in hydrology discussed below.

HABITAT FRAGMENTATION

Habitat fragmentation occurs when large blocks of continuous habitat are broken up into smaller blocks by the creation of breaks consisting of different kinds of habitat. In the area surrounding Bayou Teche NWR, habitat fragmentation is obviously a consequence of habitat conversion, but its effects are distinct, and the difference is important to conservation efforts. Fragmentation affects ecosystem structure and function in a number of ways, and the effects depend on the pattern and spatial properties of the remaining fragments, as well as their size. For example,

blocks of forest which are separated by a road or pipeline right-of-way may retain much of their shared function as habitat for wide-ranging species such as Louisiana black bear, which are able to cross short distances of inhospitable habitat, while similar-sized blocks that are separated by large distances may effectively isolate those same wide-ranging species.

Habitat fragmentation can result in decline or loss of wide-ranging and interior-dependent species (U.S. Fish and Wildlife Service 1995), increased invasion by exotic plants and animals, decreased (or increased) species diversity (Rudis 1995), and changes in predator, parasite, and pathogen populations and effects. In bottomland forests, documented effects of fragmentation include declines in forest interior breeding bird species such as swallow-tailed kite, prothonotary warbler, and Acadian flycatcher (Rich et al. 2004). In the area surrounding Bayou Teche NWR, habitat fragmentation threatens the continued survival of Louisiana black bear (U.S. Fish and Wildlife Service 1995). Habitat restoration in existing habitat breaks or creation of corridors of hospitable habitat to reconnect fragments can restore much of the function of these habitats without requiring wholesale re-conversion to forest. The existing acquisition boundary for the refuge (Figure 2) includes areas between fee-title tracts which, if restored to bottomland hardwood forest, would largely mitigate the threat of fragmentation for Louisiana black bear on Bayou Teche NWR.

CONVERSION OF DRIER TO WETTER HABITAT TYPES

The construction of a system of levees and drainage pumps to protect cane fields in St. Mary Parish, along with changes in relative sea level and the construction of canals open to the Gulf of Mexico has resulted in habitat changes both inside and outside the levee-protected areas. Outside the levees, flooding has become more prolonged, with fewer dry-down periods. In some cases, for example in the North Bend West Unit of Bayou Teche NWR, this change appears to be resulting in gradual change from cypress-tupelo swamp to emergent marsh vegetation dominated by cattails. More such habitat shifts can be expected if hydrologic changes persist, since neither baldcypress nor tupelogum can regenerate in standing water (Burns and Honkala 1990).

CONVERSION OF WETTER TO DRIER HABITAT TYPES

Inside the levee-protected areas, frequency and duration of flooding have decreased. Areas which supported bottomland hardwoods before hydrologic modification can still support those habitat types, but areas which would naturally be covered by cypress-tupelo swamp (Harahan and Allemands soils) now support hardwoods. These areas are found in the eastern portion of the Franklin Unit and small areas in the northwest of the Garden City Unit (Appendix E).

CONSTRUCTION OF CANALS AND SPOIL BANKS

The demands of transportation, commerce, and resource extraction have resulted in construction of a network of canals throughout coastal Louisiana, including Bayou Teche NWR. These canals provide open, relatively deepwater habitat fringed by spoil banks, which serve as narrow lanes of high ground, where only swamp or marsh existed before. Canals alter hydrology and fragment swamp and marsh habitat, and as noted above, they function as corridors for invasive species. On Bayou Teche NWR, canals are infested with floating exotic invasive aquatic weeds, primarily water hyacinth (*Eichhornia crassipes*), salvinia (*Salvinia molesta, S. minima*), and Cuban sedge (*Oxycaryum cubense*). These plants form floating mats which impede boat traffic, shade out rooted aquatic plants, and cause anoxic conditions in the

water column. Spoil banks on the refuge are vegetated by early successional hardwood species, including sweetgum, red maple, black willow, water oak, and sugarberry. Chinese tallowtree (*Triadica sebifera*), an exotic invasive tree, is also present on spoil banks over much of the refuge. Spoil banks are used by Louisiana black bears, particularly in the Franklin Unit.

CHANGES ASSOCIATED WITH GLOBAL CLIMATE CHANGE

Global climate has been relatively stable over the last 10,000 years (U.S. Environmental Protection Agency 2011). It is now known that human activities—primarily consumption of fossil fuels and deforestation, are having a profound influence on Earth's climate. Climate warming is unequivocal, as is evident from observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global average sea level (IPCC 2007). The U.S. Climate Change Science Program (CCSP) published findings in agreement with the IPCC report, stating that "studies to detect climate change and attribute its causes using patterns of observed temperature change in space and time show clear evidence of human influences on the climate system (due to changes in greenhouse gases, aerosols, and stratospheric ozone)" (CCSP 2009). For Bayou Teche NWR, the most important consequences of climate change are sea level rise and an increase in the frequency and/or intensity of tropical cyclones. Additional consequences will likely be shifts in phenology and species distribution, with more temperate flora and fauna being gradually replaced by subtropical and tropical species.

Because of the uncertainty of the intensity and distribution of impacts caused by increasing global average temperatures, monitoring will be an essential component of management. Gathering timely, relevant data on climate-induced habitat changes will facilitate adaptive management and allow managers to plan for future conditions. The following sections summarize some of the potential consequences of climate change on the refuge.

Sea Level Rise Associated with Climate Change

According to the Intergovernmental Panel on Climate Change (IPCC 2007), global mean sea level continues to rise due to thermal expansion of the oceans and melting of glaciers, ice caps and the Greenland and Antarctic Ice Sheets (Church et al. 2001, Bindoff et al. 2007). Recent work (Pokhrel et al. 2012) has also implicated unsustainable mining of "fossil water" in unrecharged aquifers for irrigation as a major source of sea level rise since 1961. There is high confidence that the rate of sea level rise has increased between the mid-19th and the mid-20th centuries (Bindoff et al. 2007). For the 20th century, the average rate was 1.7 ± 0.5 mm/yr (0.07 ± 0.02 in/yr), consistent with the 2001 IPCC estimate of 1-2 mm/yr (0.04 to 0.08 inches/year) (Bindoff et al. 2007, Church et al. 2001). However, satellite observations available since the early 1990s provide more accurate sea level data with nearly global coverage. This decade-long satellite altimetry data set shows that since 1993, sea level has been rising at a rate of around 3.1 ± 0.7 mm/yr (0.12 ± 0.03 inches/year), significantly higher than the average during the previous half century (Bindoff et al. 2007). Furthermore, several recent studies are predicting higher rates of sea level rise than what has been reported in the IPCC AR4 report (IPCC 2007). The projected increased rates of sea level rise have been attributed to a greater contribution of melting glaciers and increased ice-sheet flow. More recent estimates of sea level rise are higher than the 2007 IPCC estimate; for example (Vermeer and Rahonstorf 2009) estimated that global average sea level would rise 6.8 – 17.3 mm/yr (0.27 - 0.68 inches/yr), or .75 – 1.9 m (30 – 75 inches) from 1990 levels by 2100.

Relative sea level rise on the Louisiana coast is significantly higher than the global average because of local subsidence. The National Water Level Observation Network (NWLON) is operated by NOAA and is composed of approximately 175 long-term, continuously operating stations located along the United States' coast. There are reliable data from some stations going back over 150 years (NOAA 2011). The NWLON station nearest to the refuge is Grand Isle (station #8761724). At this location, the mean sea level trend is 9.1 mm/yr (0.36 inches/year) with a 95 percent confidence interval of +/- 0.5 mm/yr (0.02 inches/year). This estimate is based on monthly mean sea level data from 1947 to 2006, and is equivalent to a change of 92 cm (3.03 feet) in 100 years (NOAA 2010). Thus, local sea level rise is almost three times greater than the global average, with serious potential consequences to refuge resources.

Much of Bayou Teche NWR lies at or very close to sea level. As sea levels rise, habitat conversion from swamp to marsh, and from freshwater to more saline conditions, will accelerate. Storm surge events like the one associated with Hurricane Rita in 2005 will reach higher elevations, compromising the levee system which protects farmland in the parish and causing flooding of protected lands.

Effects of Climate Change on Tropical Cyclones

Because tropical cyclone intensity is directly correlated to sea surface temperature (among other factors), it has been theorized that global warming could increase the intensity of tropical cyclones (Emanuel 1987). A recent study has shown that increases in average wind speed of powerful hurricanes from 140 miles an hour in 1981 to 157 miles an hour in 2007 were correlated with increases in sea surface temperatures (Elsner et al. 2008). The findings are based on 26 years of data from weather satellites with the trend toward stronger hurricanes being particularly notable in the North Atlantic Ocean—the source of hurricanes that strike the U.S. East Coast, Gulf of Mexico, and Caribbean. It is likely that future large hurricanes, fueled by increasingly warmer waters, will affect the refuge.

Changes in Phenology and Species Distribution Due to Climate Change

Although the precise effects of climate change on the refuge are unknown, it is highly likely that the increase in temperatures will cause the distributional shift of some species or whole communities as summarized by (Fischlin et al. 2007). Species from lower latitudes, including animals and plants exotic to the Americas as well as neotropical species, will become more prevalent, while some temperate species will decline (McCarty 2001; Parmesan and Yohe 2003; Root et al. 2003; Hannah et al. 2005; Parmesan 2006). As migratory species often move annually in response to seasonal climate changes, their behavior, including migratory routes, is sensitive to climate. Numerous studies have found that many of these species are arriving earlier. Changes in the timing of biological events are of particular concern because of a potential disconnect between migrants and their food resources if the phenology of each advances at different rates (Root et al. 2003).

III. Resources of Concern

INTRODUCTION

The Service is entrusted by Congress to conserve and protect migratory birds and fish, federally listed threatened and endangered species, inter-jurisdictional fishes, and certain marine mammals. These are known as "trust species." In addition to this Service mandate, each refuge has one or more purposes for which it was established that guide its management goals and objectives. Further, refuges support other elements of biological diversity, including invertebrates, rare plants, unique natural communities, and ecological processes that contribute to biological integrity, diversity, and environmental health at the refuge, ecosystem, and broader scales (U.S. Fish and Wildlife Service 1999), (601 FW3).

The Habitat Management Plan policy (620 FW) defines "resources of concern" as:

All plant and/or animal species, species groups, or communities specifically identified in refuge purpose(s), Refuge System mission, or international, national, regional, state, or ecosystem conservation plans or acts. For example, waterfowl and shorebirds are a resource of concern on a refuge whose purpose is to protect "migrating waterfowl and shorebirds." Federal or state threatened and endangered species on that same refuge are also a resource of concern under terms of the respective endangered species acts.

The refuge CCP (U.S. Fish and Wildlife Service 2009a) states that:

While other public lands in Louisiana have Louisiana black bears, Bayou Teche NWR is the only public land established specifically for the conservation of the Louisiana black bear, with the bear as the top priority management objective. Other priority species include migratory birds such as bald eagles and other raptors, waterfowl, neotropical songbirds, and wading birds.

In accordance with the purpose of Bayou Teche NWR, we selected a single Resource of Concern, the Louisiana black bear, on which to focus habitat management efforts. Other species groups listed in the CCP as priority species for the refuge are included as Species with Complementary Habitat Requirements (Section 3.5 below), since management decisions are not made based on the requirements of these species, but they are expected to benefit from habitat management for the Louisiana black bear.

LOUISIANA BLACK BEAR

The only resource specifically defined in the Bayou Teche NWR purpose is the Louisiana black bear. Management actions described in this Habitat Management Plan are primarily designed to benefit the coastal population of Louisiana black bears, although they will benefit other species dependent on bottomland hardwood forests, baldcypress-tupelogum swamps, and freshwater marsh habitats as well.

The Louisiana black bear (*Ursus americanus luteolus*) is a subspecies of black bear that formerly ranged from eastern Texas to southern Mississippi, including all of Louisiana. Three current breeding populations of this subspecies, which was listed as threatened under the

Endangered Species Act on January 7, 1992, exist; two in the Atchafalaya and one in the Tensas River corridors in Louisiana (U.S. Fish and Wildlife Service 1995; Benson 2005). Louisiana black bears are wide-ranging animals that prefer bottomland hardwood forests. Large contiguous blocks of habitat are required to support viable populations of this species. Home ranges are reported to be approximately 20-60 square miles for males and 4-30 square miles for females (U.S. Fish and Wildlife Service 1995). Black bear habitat must meet all of the needs of the animals throughout the year, including requirements for food, water, dens, and cover, and be large enough to ensure that breeding encounters occur (U.S. Fish and Wildlife Service 1995). In Louisiana, black bears use large hollow trees or other protected locations near the ground for dens during the winter. Threats to Louisiana black bears include habitat loss and fragmentation, direct mortality from illegal and/or unregulated hunting, and highway mortality. Since the subspecies was listed, take is legally proscribed, and enforcement actions are used to address the threat of illegal hunting.

Critical habitat has been designated for the Louisiana black bear in the Tensas River corridor, along the Atchafalaya corridor, and on the Gulf coast from Avery Island to Morgan City, including all units of Bayou Teche NWR except Centerville (Figure 5).

Currently, the Tensas River corridor supports the largest, healthiest population of Louisiana black bears within the range of the species. Since the Louisiana black bear was listed in 1992, 123 bears have been relocated from Tensas River NWR to locations in the Atchafalaya Basin in an effort to repopulate other suitable habitat within the historical range of the subspecies. Delisting criteria for the Louisiana black bear include the presence of two viable populations linked by a dispersal corridor that ensures gene flow between the two populations (U.S. Fish and Wildlife Service 1995). Work is ongoing to estimate the viability of existing populations in the Tensas and Atchafalaya Basins and along the coast. No results are available yet from that research, but it is assumed that increasing the quality and quantity of habitat available to bears in the current range will increase the viability of those populations.

HABITAT REQUIREMENTS OF LOUISIANA BLACK BEAR

Louisiana black bears formerly ranged through eastern Texas, Louisiana, and western Mississippi. They are able to use a variety of bottomland and upland habitats, but bottomland hardwood forests are preferred, because of their higher production of hard and soft mast (U.S. Fish and Wildlife Service 1995). Requirements for food, water, cover, and den sites are best met in large, relatively remote blocks of bottomland hardwood forest habitat. Each of these habitat components will be discussed individually.

Black bears are omnivorous, opportunistically consuming soft and hard mast, grass and other vegetation, invertebrates, carrion, and agricultural crops such as wheat, oats, and corn (U.S. Fish and Wildlife Service 1995). In bottomland hardwood forest habitat, hard mast consists mostly of acorns (fruit of *Quercus* spp.) and pecans (fruit of *Carya illinoensis*), while soft mast comes from a variety of understory plants including mulberries (*Morus* spp.), pawpaw (*Asimina triloba*), plums/cherries (*Prunus* spp.), blackberries (*Rubus* spp.), elderberry (*Sambucus canadensis*), pokeweed (*Phytolacca americana*), devil's walkingstick (*Aralia spinosa*), and palmetto (*Sabal minor*) (LMVJV Forest Resource Conservation Working Group 2007). Most of these understory plants produce significant quantities of fruit only when they receive direct sunlight, although many can persist in shaded understory conditions. Working in the Tensas River bottom in northeastern Louisiana, (Benson and Chamberlain 2006) reported

that Louisiana black bears consumed mainly beetles, blackberries, and corn during the summer, and subsisted mostly on acorns and herbaceous vegetation during the winter. During the fall, the bears' diet was dominated by palmetto fruit and acorns. Interestingly, they also found that a subpopulation of bears which inhabits managed, commercial forest blocks (the "Deltic" population) had smaller home ranges and a more diverse diet than those on Tensas River NWR, which had had little timber harvesting for the preceding two decades. The authors speculated that this difference was caused by a relative paucity of understory vegetation on the refuge as compared to the managed timberlands, a condition that may be related to management differences, as well as the fact that the commercial timberlands are subject to less-frequent flooding.   (Hellgren et al. 1991), working in Virginia, found that disturbed areas in the Great Dismal Swamp were heavily used by black bears for feeding, because of availability of soft mast-producing plants in the understory. Likewise, (Mitchell and Powell 2003) found that timber harvesting on the Pisgah National Forest in North Carolina increased soft mast production, but noted that in a managed forest there is a trade-off between increased soft mast from early successional plants and decreased hard mast and den sites produced by the overstory trees, and increased risk of human contact due to road construction.

Open water influences the quality of black bear habitat in a number of ways. Dependable sources of drinking water are important for black bear habitat. In southern Louisiana, open water is rarely limited, but flooding can limit options for den sites (Black Bear Conservation Committee, n.d.; White et al. 2001) and may reduce understory food plants (Benson and Chamberlain 2006). Rivers may serve as barriers to movement for bears. (White et al. 2000) reported that in Arkansas, the Mississippi River (approximately 1,600 miles wide) effectively deflected bear movement, while the White River, which is approximately 200 miles wide, was less of a barrier. Male bears were more likely to cross than females, and all bears were less likely to cross in the winter.

Escape cover is an important feature of black bear habitat. In hunted populations in North Carolina, dense underbrush associated with Carolina bays was critical for concealment and escape from hunters and dogs (Landers et al. 1979). Likewise, large swamps in northern Florida are important for escape cover for Florida black bears because human access is limited (Mykytka and Pelton 1990). Although bears use roads for travel corridors in dense vegetation, they risk vehicle strikes and detection by hunters by doing so. Hunted populations tend to avoid roads for this reason (Hellgren et al. 1991).   (Mitchell and Powell 2003) also noted the high value of dense vegetation in recently harvested forest stands for escape cover.

Louisiana black bears require secure denning sites for wintering and day use. In northeastern Louisiana, most bear dens are in tree cavities which are elevated above flood levels (Weaver and Pelton 1994). Bears may also use brush piles or other sites on the ground, but these sites are more susceptible to human disturbance (Weaver and Pelton 1994) and more vulnerable to flooding (Hightower et al. 2002; White et al. 2001). (Hightower et al. 2002) reported that black bears in the Atchafalaya River corridor used tree dens and ground dens in about equal proportions, except for areas along the coast, where mostly ground dens were used. They concluded that concealment is the most important factor related to den sites, and that reproductive status of the female bears they studied did not affect den choice. Dens in their study were preferentially in areas of dense understory cover. They found that although den sites did not appear to be limiting, that den trees should be protected in bear habitat so that den sites which are less susceptible to flooding will be available. (White et al. 2001), working in the White River and the Mississippi River bottoms in eastern Arkansas, reported that black bears selected elevated tree dens in flood-

prone habitat, and recommended that in areas where tree-cavity dens were unavailable, that logging slash piles (used as den sites in the absence of suitable tree cavities) should be preferentially left on higher ground to reduce litter losses from den flooding.

Black bears tend to avoid human contact, although they are attracted to human-influenced areas where garbage and other edible material are available. Remoteness of habitat, influenced by forest block size and degree of fragmentation, is therefore an important habitat variable (Rudis and Tansey 1995). Bears have large home ranges (20 to 60 square miles for males and 4 to 30 square miles for females), and require large areas for genetically viable populations to persist (U.S. Fish and Wildlife Service 1995). Landscape-scale considerations for black bear habitat are therefore important specifically block size and connectivity (U.S. Fish and Wildlife Service 1995; Benson 2005).

POTENTIAL REFUGE CONTRIBUTION TO HABITAT REQUIREMENTS OF LOUISIANA BLACK BEAR

Bayou Teche NWR currently consists of 6 small- to mid-sized blocks of habitat, most of which is poor to moderate in quality for the Louisiana black bear. Bear use is concentrated in patches of bottomland hardwood forest, and most of the better quality bear habitat in the coastal population area is on private lands. The best habitat on the refuge is located in blocks of hardwood forest in North Bend East, Franklin, and Garden City Units. The North Bend East Unit, in particular, is adjacent to a large block of privately owned bottomland hardwood forest which contains some of the better bear habitat in the parish. Baldcypress – tupelogum swamp habitat is used by Louisiana black bears on Bayou Teche, but the habitat quality is poor because of frequent flooding and the lack of hard mast. Spoil banks along canals are used preferentially in these areas.

Acquisition and restoration of lands within the current approved acquisition boundary for the refuge (Figure 2) would increase habitat connectivity and result in substantial improvement of conditions for Louisiana black bear, as well as other species which depend on large blocks of bottomland hardwood.

SPECIES WITH COMPLEMENTARY HABITAT REQUIREMENTS

Habitat objectives and strategies will be established based primarily on the habitat needs of the above-identified resource of concern. However, an ecosystem management approach to habitat management will result in overall improvement in the health and function of the ecosystem on the refuge, benefitting many other species, including those for which the Service has specific legal responsibility under Federal law. The following species groups are listed in the refuge CCP (U.S. Fish and Wildlife Service 2009a) as priorities for the refuge, have habitat needs that are similar to or compatible with those of the resource of concern, and are therefore expected to benefit from management designed to meet the needs of the resource of concern. They are not included as resources of concern because management actions are not taken specifically to benefit habitat for them.

RAPTORS

Raptors which regularly use the refuge include bald eagle, turkey vulture, black vulture, osprey, swallow-tailed kite, Mississippi kite, sharp-shinned hawk, Cooper's hawk, northern harrier, red-shouldered hawk, broad-winged hawk, red-tailed hawk, and American kestrel (Table 3).

WATERFOWL

A number of species of ducks, notably wood ducks, black bellied whistling ducks, teal, and gadwall, use the refuge, either during winter or year-round. Habitats on Bayou Teche NWR which support these species include baldcypress – tupelogum swamp and fresh marsh (Table 3). Bottomland hardwood forest provides hard mast for wood ducks, which depend for much of their winter nutrition on acorns (U.S. Geological Survey 2006).

NEOTROPICAL SONGBIRDS

A host of neotropical migratory songbirds use the refuge; however, a subset of those have been identified as requiring unfragmented habitat for breeding (Mueller et al. 2000). We have listed these species because management for Louisiana black bear, in particular restoring relatively unfragmented bottomland hardwood forest, will directly benefit them.

WADING BIRDS

Bayou Teche NWR's wetlands provide excellent habitat for a number of wading birds. Wading birds require rookery sites for roosting and breeding, as well as shallow waters with sufficient prey abundance within commuting distance. Maintaining marsh and swamp vegetation on the refuge, as well as controlling exotic invasive floating plants on canals and promoting native woody vegetation on spoil banks, will enhance habitat quality for wading birds.

Table 3. Species with complementary habitat requirements to those of Louisiana black bear on Bayou Teche NWR

Common Name	Habitat Use on Bayou Teche National Wildlife Refuge			
	Bottomland Hardwood Forest	**Baldcypress – Tupelogum Swamp**	**Freshwater Marsh**	**Open Water**
RAPTORS				
Bald Eagle	x	X		x
Turkey Vulture	x			
Black Vulture	x			
Osprey		X		x

Common Name	Habitat Use on Bayou Teche National Wildlife Refuge			
	Bottomland Hardwood Forest	Baldcypress – Tupelogum Swamp	Freshwater Marsh	Open Water
Swallow-tailed Kite	x	X	x	
Mississippi Kite	x	X	x	
Sharp-shinned Hawk	x		x	
Cooper's Hawk	x		x	
Northern Harrier			x	
Red-shouldered Hawk	x		x	
Broad-winged Hawk	x		x	
Red-tailed Hawk	x		x	
American Kestrel			x	
Barred Owl	x	X	x	
Great Horned Owl	x	X	x	
WATERFOWL				
Black-bellied Whistling Duck	x	X	x	
Gadwall		X	x	
Blue-winged Teal		X	x	
Green-winged Teal		X	x	
Wood Duck	x	X	x	

Common Name	Habitat Use on Bayou Teche National Wildlife Refuge			
	Bottomland Hardwood Forest	Baldcypress – Tupelogum Swamp	Freshwater Marsh	Open Water
NEOTROPICAL SONGBIRDS				
Acadian Flycatcher	x			
Great Crested Flycatcher	x			
Yellow-throated Vireo	x			
Red-eyed Vireo	x			
Blue-gray Gnatcatcher	x			
Wood Thrush	x			
Northern Parula	x			
Yellow-throated Warbler	x			
American Redstart	x			
Prothonotary Warbler	x	X		
Swainson's Warbler	x			
Kentucky Warbler	x			
Hooded Warbler	x			
Summer Tanager	x			
WADING BIRDS				
American Bittern	x	X	x	

Common Name	Habitat Use on Bayou Teche National Wildlife Refuge			
	Bottomland Hardwood Forest	Baldcypress – Tupelogum Swamp	Freshwater Marsh	Open Water
Great Blue Heron	x	X	x	
Great Egret	x	X	x	
Snowy Egret	x	X	x	
Little Blue Heron	x	X	x	
Tricolored Heron	x	X	x	
Reddish Egret	x	X	x	
Cattle Egret	x	X	x	
Green Heron	x	X	x	
Black-crowned Night-Heron	x	X	x	
Yellow-crowned Night-Heron	x	X	x	
White Ibis	x	X	x	
Glossy Ibis	x	X	x	
White-faced Ibis	x	X	x	
Roseate Spoonbill	x	X	x	
Wood Stork	x	X	x	

IV. Habitat Management Goals and Objectives

The following habitat management and wildlife population management goals and objectives were developed for the CCP (U.S. Fish and Wildlife Service 2009a) and form the basis of this HMP:

GOAL 1. Identify, conserve, manage, and restore populations of native fish and wildlife species representative of the Lower Atchafalaya Basin, with emphasis on Louisiana black bears, migratory birds, and other threatened and endangered species.

Objective 1.1: Manage and protect threatened and endangered species, primarily Louisiana black bears, through implementation of recovery plans.

Strategies:

- Coordinate with the Service's Ecological Services Office, LDWF, universities, and Black Bear Conservation Committee in recovery efforts of the coastal population of the Louisiana black bear.
- Respond to nuisance bear calls when needed; assist adjacent landowners with bear issues.
- Coordinate with the Service's Ecological Services Office, LDWF, and universities to index threatened and endangered plant species on the refuge and monitor and document locations with field technicians.
- Reference the Louisiana Black Bear Management Plan for management direction.

Objective 1.2: Monitor species of concern, targeted species, and species of federal responsibility in order to assess management goals.

Strategies:

- Continue bear bait stations on refuge (concentrate on using natural baits).
- Coordinate and cooperate with university research on the Louisiana black bear.
- Continue survival of the coastal population of the Louisiana black bear.
- Monitor use of refuge with trail cameras.
- Continue use of a summer student biological technician to help collect data.
- Continue feral hog control (refer to Hunt Plan).
- Monitor alligator and nutria population via spotlight surveys to determine need for management actions.
- Coordinate with the Service's Ecological Services Office, LDWF, fisheries, local birding groups, and universities to assess use of refuge by neotropical migratory birds.

Objective 1.3: Monitor resident and other species utilizing habitat on the refuge.

Strategies:

- Monitor forage availability for white-tailed deer, herd density (browse surveys), and harvest.
- Monitor use of forested areas by squirrels.
- Monitor use of marsh and forested wetlands by rabbits.
- Monitor densities of other fur-bearer species using habitat on the refuge.

Objective 1.4: Monitor fish and shellfish habitat on the refuge.

Strategies:

- Monitor fish and shellfish species present on refuge via coordination with LDWF, Inland and Marine Fish divisions, and report all fish kills.
- Continue correspondence with local fishermen and sportsmen to assess species in daily catch.

GOAL 2. Restore, improve, and maintain a mosaic of forested and wetland habitats native to the Lower Atchafalaya Basin in order to ensure healthy and viable plant and animal communities, with an emphasis on threatened and endangered species.

Objective 2.1: Manage and maintain fresh marsh and other aquatic habitats for refuge resources.

Strategies:

- Control invasive aquatic plant species in canals and waterways.
- Plan mitigation projects to revive flotant marsh areas.
- Maintain fish, amphibian, and reptile populations.
- Develop a habitat management plan by 2013.
- Monitor effects of public use on habitat and refuge resources.

Objective 2.2: Manage, maintain, and enhance, when possible, bottomland hardwood and cypress/tupelo swamp habitats and associated ridges and spoil banks for refuge resources.

Strategies:

- Stabilize shorelines via cooperation with research projects, state and federal agencies, and coastal restoration grants.
- Plant hardwood species when opportunity arises.
- Develop a habitat management plan by 2013.

Objective 2.3: Support partnerships to protect natural habitats of the Teche/Vermillion and Atchafalaya Basins.

Strategies:

- Continue cooperation with USGS on cypress/tupelo swamp salt tolerance study on the refuge.
- Continue to cooperate with LDNR's Coast-wide Reference Monitoring System (CRMS) project.
- Promote future projects with state and federal agencies, universities, and non-governmental organizations to improve habitat, fund coastal erosion projects, and acquire additional refuge lands as funding and willing sellers are available.

HABITAT MANAGEMENT PLAN GOAL 1: BOTTOMLAND HARDWOOD FORESTS

Restore and manage bottomland hardwood forests on Bayou Teche NWR to function as high-quality Louisiana black bear habitat.

Discussion: Bayou Teche NWR currently has about 1,800 acres of bottomland hardwood forest, much of it in degraded condition due to previous high-grading and changes in drainage patterns associated with levees and canals. This habitat is mostly in small fragments; the largest is approximately 533 acres, while the smallest is less than 50 acres. However, the bottomland hardwood portions of the Franklin and Garden City Units, which total more than 1,000 acres, are part of a larger contiguous area of naturally and artificially regenerated hardwood forest inside the flood-protection levee. This block is approximately 2,476 acres in size. Likewise, the 533-acre North Bend East Unit, which is mostly bottomland hardwoods, is part of a 10,700-acre block of natural habitats inside the flood protection levee which consists of artificially drained bottomland hardwood and cypress-tupelo swamp habitat. Restoring the refuge-owned habitat within these blocks to high-quality hardwood forest would enhance conditions for Louisiana black bears in the coastal population.

Objective 1.1: Improve Bottomland Hardwood Forest Habitat

Beginning by 2016, and every 3 to 4 years thereafter, approximately 1/3 of the 1,472 acres of operable bottomland hardwood forest on Bayou Teche NWR will be evaluated, and if necessary, will be treated silviculturally to produce the following conditions (LMVJC Forest Resource Conservation Working Group 2007):

- Overstory canopy cover 60 to 70 percent
- Midstory cover 25 to 40 percent
- Basal area 60 to 70 square feet/acre
- Tree stocking 60 to 70 percent
- >2 emergent canopy trees/acre
- Understory cover 25 to 40 percent
- At least 400 advance regeneration stems of shade-intolerant tree species (water oak, green ash, sweetgum) over 30 to 40 percent of area

- ≥200 feet^3/acre of coarse (>10-inch diameter) woody debris
  - 4 visible small cavities/acre, or > 4 "snag" stems ≥ 4 inch dbh, or ≥ 2 stems > 20-inch dbh
- 1 visible large cavity/den tree/10 acres or ≥ 2 stems ≥ 26 inch dbh, (≥ 8 ft2 BA ≥ 26 inch dbh)
  - 6 snag or stressed tree stems/acre ≥ 10 inch dbh, or ≥ 2 stems ≥ 20 inch dbh, (> 4 feet/2 BA ≥ 10-inch dbh)

Rationale: The Lower Mississippi River Valley Joint Venture Forest Resource Conservation Working Group (LMVJV Forest Resource Conservation Working Group 2007) described desired conditions for bottomland hardwood forests and landscape-scale factors affecting wide-ranging species, primarily Louisiana black bears, and forest interior-dependent birds. Priority zones for forest restoration to support Louisiana black bears were identified, and Bayou Teche NWR is in the zone of highest priority. Stand conditions recommended in this document include canopy cover and stocking rates in the 60 to 70 percent range with ample (25 to 40 percent) midstory and understory cover, basal area between 60 and 70 square feet per acre (13.8-16.1 m^2/ha), and the presence of coarse woody debris, small and large (i.e., den-sized) cavities, snags, and stressed trees. Plant species diversity is important as well, since fruit and insect crops from various species are available at different times of the year (LMVJV Forest Resource Conservation Working Group 2007). Creating these conditions through silvicultural treatments will improve the habitat quality for Louisiana black bears and help fulfill the purpose of the refuge.

Resource of Concern: Louisiana black bear

CCP Objective: 1.1, 2.2

Adaptive Management Monitoring Elements

Primary Habitat Response Variables	Probable Assessment Methods
▪ Basal area of mast-producing trees ▪ Presence and number per acre of usable den trees ▪ Quantity, quality, and timing of soft mast produced	▪ Periodic cruises ▪ Surveys
Primary Wildlife Response Variables	**Probable Assessment Methods**
▪ LBB population and use of habitat	▪ Surveys

Objective 1.2*:* Forest Restoration

As lands become available, over the 15 years covered by this Habitat Management Plan, reforest cleared acreage by artificially regenerating appropriate hardwood species to recreate high-quality, diverse bottomland hardwood forest/bear habitat. Work through partnerships to encourage restoration of bottomland hardwood forest habitat on partner lands.

Rationale: Land acquisition, although not within the scope of this Habitat Management Plan, is an ongoing program at Bayou Teche NWR. Ample opportunities for land acquisition exist within the current 36,657-acre approved acquisition boundary (Figure 2). As new lands are acquired that will support bottomland hardwood forests, but which have been cleared for agriculture, they should be reforested with a species mix appropriate to the soil and flooding regimes on the site. Habitat elements described in LMVJV Forest Resource Conservation Working Group (2007) are the eventual goal. Plantings should favor species which provide hard and soft mast and have the capacity to become den trees; however, species diversity is also important.

Resource of Concern: Louisiana black bear

CCP Objective: 1.1, 1.2, 2.2, 2.3

Adaptive Management Monitoring Elements

Primary Habitat Response Variables	Probable Assessment Methods
▪ Basal area and/or density of mast-producing trees	▪ Periodic cruises
Primary Wildlife Response Variables	**Probable Assessment Methods**
▪ Use by LBB	▪ Surveys

HABITAT MANAGEMENT PLAN GOAL 2: CYPRESS-TUPELO SWAMP AND FRESHWATER MARSH

Manage cypress-tupelo swamp and associated marsh habitat on Bayou Teche NWR to provide high-quality swamp and marsh habitat for the Louisiana black bear and other trust species, and maintain biological integrity, diversity, and ecosystem health as swamp converts to marsh.

Objective 2.1: Control of Invasive Plants

Every year, maintain populations of invasive plants on spoil banks, canals, and other habitats on the refuge at levels which do not impair habitat quality for Louisiana black bears or other wildlife and which do not interfere with human access or degrade aquatic habitat.

Rationale: Invasive plants displace more desirable components of habitat and in some cases impede access for managers and refuge visitors. On Bayou Teche NWR, two types of habitat are particularly susceptible to invasive plants. On spoil banks, Chinese tallowtree has invaded and has the potential to displace native trees with higher value to wildlife. Since spoil banks function as travel corridors and refugia for Louisiana black bears, maintaining them in the best condition possible will benefit this resource of concern. Canals and other open water areas are susceptible to invasion by exotic floating plants which form impenetrable mats of vegetation. These mats are composed of salvinia, water hyacinth, and Cuban sedge, as well as other plants which colonize the mats, including native species such

as pennywort (*Hydrocotyle ranunculoides*) and maidencane (*Panicum hemitomon*). Floating mats of this type impede traffic in the canals and shade out rooted aquatic species which are more valuable for wildlife. When the mats die back in the winter, they can cause anoxic conditions in the water column as they sink and decompose.

Resource of Concern: Louisiana black bear

CCP Objectives: 1.1, 1.2, 2.1, 2.2

Adaptive Management Monitoring Elements

Primary Habitat Response Variables	Probable Assessment Methods
▪ Cover of exotic invasive plants	▪ Periodic surveys
Primary Wildlife Response Variables	**Probable Assessment Methods**
▪ Use of spoil banks by LBB ▪ Use of open water by waterfowl	▪ Surveys

HABITAT MANAGEMENT PLAN GOAL 3: EXOTIC ANIMALS (REFUGE-WIDE)

Wildlife habitats and the biological integrity, diversity, and ecosystem health of Bayou Teche NWR will be minimally affected by feral hogs, nutria, and other exotic animals.

Objective 3.1: Control of Invasive Exotic Animals (Refuge-wide)

Every year, maintain populations of feral hogs and nutria below levels at which they produce significant damage to bottomland hardwood forests, cypress-tupelo swamps, and marsh habitats.

Rationale: Feral hogs and nutria have the potential to significantly degrade habitat for Louisiana black bear and other native wildlife on Bayou Teche NWR. Hogs destroy forest regeneration, compete with native wildlife for food resources, and carry diseases which can spread to native wildlife. Nutria can denude large areas of marsh and damage baldcypress regeneration. Controlling these animals is necessary to provide high-quality habitat for the refuge's resource of concern.

Resource of Concern: Louisiana black bear

CCP Objectives: 2.1, 2.2

Adaptive Management Monitoring Elements

Primary Habitat Response Variables	Probable Assessment Methods
▪ Presence of nutria "eat-outs" and feeding platforms ▪ Availability of hard mast ▪ Presence of rooted areas	▪ Periodic surveys
Primary Wildlife Response Variables	Probable Assessment Methods
▪ Availability of food resources to LBB	▪ Surveys

V. Management Strategies

BOTTOMLAND HARDWOOD MANAGEMENT STRATEGIES

Management of bottomland hardwoods on Bayou Teche NWR will be focused on providing high-quality habitat for the Louisiana black bear; this focus will also benefit migratory and resident birds and other wildlife species. The Endangered Species Act requires the Service to conserve listed species, and its policy is to maintain biological diversity on refuge lands. In accordance with the objectives of the Refuge System, threatened and endangered species have precedence in all refuge management decisions. Forested habitat will also be managed for other trust species where endangered species requirements are not compromised. Our approach will be to increase the population viability of the Louisiana black bear through habitat management, under the assumption that management for this species' habitat will benefit many other species within its ecological community.

POTENTIAL STRATEGIES

Hardwood forests on Bayou Teche NWR can, at least in principle, be managed at a range of intensities from passive to active to achieve the objectives described in Section 4.1 above and in (LMVJV Forest Resource Conservation Working Group 2007). Challenges for managers include small block size (the largest hardwood forest block on the refuge is approximately 500 acres), fragmentation (even the small blocks are divided by fields, pipeline rights-of-way, canals, roads, and other habitat breaks), low economic value of existing timber resources on the refuge, and limited periods of operability due to wet conditions and organic soils. Passive management options include the current management regime, which incorporates little or no silvicultural manipulation of existing stands and artificial regeneration of newly acquired open lands as needed. A more active approach could incorporate (among other treatments) thinning, group selection (patch clear-cuts), and improvement cuts. Definitions of each follow:

Thinning. This treatment is an intermediate cutting, with the primary objective being to control the growth of the stand by adjusting its density (Smith 1986). Its application in bottomland hardwood forestry, to achieve conditions described in LMVJV Forest Resource Conservation Working Group (2007), would primarily occur where dense stands of artificially or naturally regenerated timber required release to concentrate growth on desirable stems. This would occur, for example, if managers wished to accelerate the development of large stems suitable for den trees, or wished to increase the vigor of mast-producing stems in a stand. Thinning also can increase the amount of light reaching the forest floor, which will stimulate the growth of understory vegetation, including plants valuable for wildlife habitat.

Group Selection. Group selection cuts are regeneration cuts made in small areas to create or maintain an uneven-aged stand (Smith 1986). Cutting small gaps in a bottomland hardwood forest canopy (0.5-2 acres) stimulates growth of understory plants and allows regeneration of desirable, hard mast-producing tree species, while creating structural diversity important for many species of neotropical migratory songbirds.

Improvement. Timber stand improvement cuts are those which are conducted in mature stands to improve species composition and/or quality of the remaining stand (Smith 1986). This type of treatment is useful where stands have been high-graded and consist of low-value

species and stems, whether value is counted in economic or wildlife terms. On Bayou Teche NWR, improvement cuttings could be used to favor oak stems in stands with too much sugarberry, sweetgum, or elm, or to favor the development of large hollow stems for den trees.

MANAGEMENT STRATEGY PRESCRIPTIONS

The following strategies will be used to manage bottomland hardwood forest habitat in the Franklin, Garden City, and North Bend East Units to achieve the objectives listed in Section 4.1 above:

- Stand entry will be prioritized according to Table 4. The order of entry schedules a stewardship review for each unit with the intention of assessing the current conditions and developing a habitat management prescription which best achieves the habitat management objectives in Section 4.1 above. Each unit will be cruised to assess timber volume and value and habitat parameters including mast, cover, and den trees. Operability will be assessed based on soil type and road infrastructure. This "order of entry" schedule considers the timing of past habitat management actions and the recovery time necessary for leave trees to respond to the silvicultural treatments before the next entry is scheduled. The schedule also considers the temporary disturbance of a logging operation and distributes these effects across the refuge landscape over at least a 10-year period. This allows the trees time to respond to the silvicultural action, reduces local area effects, and allows wildlife an adequate cycle of benefit from the improved habitat.

- Prescribed treatments will be applied no more than once every 10 years on the same acreage. All data collected and other records will be based on management units shown in Figure 2. If a unit is reviewed, and it is determined that no active management is necessary, the next unit in the order of entry may be selected until a suitable unit requiring treatment is found. Because there are three units with potentially manageable forests, reviews will occur every 3 or 4 years on the refuge. Administrative units may be subdivided during the prescription process if necessary, allowing treatments to proceed on portions of a unit.

- Forest management prescriptions will be written for hardwood forest blocks which follow guidelines in (LMVJV Forest Resource Conservation Working Group 2007) for bottomland hardwood forest desired conditions, with special emphasis on the Louisiana black bear.

Summary of forest management process:

- Unit is selected based on priority in Table 4.
- Stewardship review is conducted for unit, including cruise and assessment of relevant variables related to silvicultural manipulation.
- If silvicultural treatment is needed, a habitat management prescription will be written for the unit.

- After approval is obtained for the prescription, it is carried out.
- Effects are monitored (Section 4.1.2 above) over time to measure progress toward objectives.
- Under ordinary circumstances, subsequent stand entry is precluded for 10 years after treatment is complete.

Table 4. Forested management unit order of entry, with approximate acreage to be inventoried and priority number

Management Unit	Forested Acreage*	Priority**
Franklin	437	1
North Bend East	533	2
Garden City	502	3

Not including spoil banks and other small, isolated areas not considered operable.
***Priority based on importance of unit to Louisiana black bear, as evidenced by current use and potential contribution to habitat.*

CYPRESS – TUPELO SWAMP MANAGEMENT STRATEGIES

POTENTIAL STRATEGIES

Management of cypress – tupelo swamp on Bayou Teche consists mostly of controlling invasive exotic plants on canals and spoil banks. Options for controlling aquatic weeds in canals (salvinia, water hyacinth, Cuban sedge, and alligator weed, among others) include chemical application, biological control, and mechanical removal. On spoil banks, the major weed is Chinese tallow, which can be controlled by a number of herbicides. More detail for important exotic weed species is given below.

Giant Salvinia

Giant salvinia *(Salvinia molesta)* and common salvinia *(S. minima)* are free-floating ferns native to Brazil. Giant salvinia was introduced in the 1990s as an ornamental through the aquarium trade to the southeastern United States where it has escaped cultivation and poses a serious threat to freshwater resources throughout the southern tier of states from Florida to Texas (U.S. Department of Agriculture 2012). Common salvinia was apparently introduced to Florida early in the 20th Century and has spread westward along the Gulf coast. The circumstances of the introduction are unclear (Jacono et al. 2001). Both of these species form dense mats of vegetation which impede boat traffic, shade out submerged vegetation, and cause anoxic conditions in aquatic habitat.

Control of salvinia with herbicides has been successful. Because of the water-repellent nature of the plant's fronds, the use of proper surfactants is required for efficacy. Herbicides which are labeled and successfully used to control salvinia in the United States include glyphosate, fluridone, and diquat (McFarland et al. 2004). Eradication of salvinia with herbicides is rarely possible, so herbicide applications must be repeated to prevent reestablishment.

A biological control agent has been successfully used to control giant salvinia in the United States and other locations in the tropics and subtropics where it is a pest. The Curculionid weevil (*Cyrtobagous salviniae)* feeds on buds and rhizomes of *Salvinia molesta*, causing dramatic declines in cover which have been shown to persist for several years without reintroduction of the weevil in Texas and Louisiana (Tipping et al. 2008). This weevil is apparently also effective against *S. minima* (Jacono et al. 2001). *C. salviniae* was released on nearby Mandalay NWR in 2011, in cooperation with Louisiana Department of Wildlife and Fisheries and Louisiana State University, and it appears to be surviving and reproducing, although it is too early to evaluate the success of the introduction.

Water Hyacinth

Water hyacinth (*Eichhornia crassipes*) is a perennial, floating herb introduced from South America as an ornamental at the 1884 World's Fair in New Orleans. It forms extensive mats which are nearly impenetrable to boat traffic and causes catastrophic changes to aquatic ecosystems in the Gulf coast region. Water hyacinth produces very little in the way of wildlife habitat value and crowds out other, more beneficial plants (Lazarine, n.d.; Fasset 1960). Water hyacinth can be controlled by physical removal of plants or by herbicide application. Biological controls have been successful in preventing water hyacinth from forming monotypic stands. Three insects that have been successfully introduced to control water hyacinth include two water hyacinth weevils (*Neochetina bruchi* and *Neochetina eichhorniae*) and the water hyacinth moth (*Niphograpta albiguttalis*). *N. bruchi* is native to Argentina and was released in 1974; it is now established in Florida, California, Texas, and Louisiana. *N. eichhorniae*, also native to Argentina, was released in 1972 and is now established throughout the southeastern United States where water hyacinth is present. *N. albiguttalis* was released in 1977 and is now established in Florida, Mississippi, and Louisiana. All of these species have been successful at reducing water hyacinth populations to some degree. *N. eichhorniae* is considered to be the most successful of the three introductions. Other control measures are usually necessary (Cervone, n.d.; Schmitz et al. 1993).

Physical removal is labor-intensive and most applicable to small infestations. Herbicides are usually required as a component of a successful program to control water hyacinth. Herbicides which can be used for its removal include 2,4-D (Weedar 1964), diquat (Reward), glyphosate (Rodeo, Aquamaster, Eraser AQ, Touchdown Pro, and AquaNeat), imazamox (Clearcast), imazapyr (Habitat), triclopyr (Renovate), and penoxsulam (Galleon) (Smith 2011).

Integrated management of this weed typically involves a combination of physical removal, herbicide application, and biological control. Physical removal may control small initial populations, while approved foliar herbicides can be used for larger areas.

Cuban Sedge

Cuban sedge (*Oxycaryum cubense*) is an exotic weed which can form monospecific or mixed floating mats of vegetation. On Bayou Teche NWR, this species colonizes infestations of salvinia in canals, contributing to the stability and biomass of floating mats. Herbicides which are effective against Cuban sedge and labeled for aquatic use include diquat, glyphosate, and imazapyr (U.S. Army Corps of Engineers 2011).

Alligator Weed

Alligator weed (Alternanthera philoxeroides) is a rooted aquatic plant of South America that forms floating mats on the margins of canals and lakes, making access difficult and crowding out plants with greater wildlife value. Biological control of this species has been largely successful using the alligatorweed flea beetle (Agasicles hygrophila) since the 1960s (Spencer and Coulson 1976).

Chinese Tallowtree

On spoil banks, the major exotic weed on Bayou Teche NWR is Chinese tallow (*Triadica sebifera*). Chinese tallowtree causes major shifts in ecosystem structure and processes, displacing native species and reducing habitat quality (Jubinsky and Anderson 1996). It was introduced into the United States first as a seed oil crop in the late 18th Century, and then later used as an ornamental. Chinese tallowtree has replaced coastal prairie vegetation with near-monotypic stands in Texas (Bruce et al. 1995) and Louisiana (Grace et al. 2005).

Options for control of this species include biological agents, mechanical removal, fire, and herbicides.

- Even though no biological control agents have been approved for use in the United States, a leaf-rolling weevil (*Heterapoderopsis bicallosicollis)* in China (Wang et al. 2009) is being evaluated for biological control.
- Mechanical removal has generally been ineffective, as soil disturbance creates opportunities for regeneration (Jubinsky 1993; Thorpe 1996).
- Fire can be an effective tool to reduce the importance of Chinese tallowtree where adequate fuels exist; however, as stand density increases, fuels become inadequate to carry fire, and mechanical or chemical treatments must be used in conjunction with fire to control this exotic (Grace et al. 2005).
- Chemical treatment is currently the most effective large-scale strategy for controlling tallowtree (Jubinsky and Anderson 1996). Herbicides which can be used include 2,4-D+2,4-DP, clopyralid (Escort), imazapyr (Arsenal), fosamine (Krenite), hexazinone (Velpar), and triclopyr (Garlon, Pathfinder) (Maddox et al., n.d.).

MANAGEMENT STRATEGY PRESCRIPTIONS

The following strategies have been selected for controlling invasive exotic plants on Bayou Teche NWR:

Chinese tallow will be controlled on spoil banks along canals and remnant road beds in the Franklin, Garden City, North Bend West, and Centerville Units, by application of Garlon 4 as a basal spray in diesel, or by other herbicide treatment as approved.

Treatment will be prioritized according to the importance of the habitat for Louisiana black bear and the potential for releasing native vegetation valuable for bear habitat, including oaks and other mast-producing species.

The refuge will work with partners (LSU, LDWF) to release *Cyrtobagous salviniae* in salvinia-infested units of Bayou Teche NWR. Timing will depend on the success of the recent release at Mandalay NWR. If that release is deemed successful based on significant reduction in cover of salvinia on the refuge, releases will be conducted on Bayou Teche NWR by 2014.

Infestations of water hyacinth, Cuban sedge, and other aquatic weeds will be managed by herbicide treatment when they pose a threat to habitat or human use by preventing access. Herbicides to be used in this effort may include 2,4-D, diquat, glyphosate, as well as other herbicides which are labeled and approved. All herbicides will be approved through the Pesticide Use Proposal process and will follow Integrated Pest Management Policy (569 FW 1). An up-to-date list of approved herbicides is kept on file at the refuge complex office.

NUTRIA/FERAL HOG MANAGEMENT STRATEGIES (REFUGE-WIDE)

POTENTIAL STRATEGIES

The feral hog (*Sus scrofa*) is an exotic species which has expanded its range throughout most of Louisiana. Hogs negatively impact the environment through habitat degradation, predation on native species, and competition with native fauna (Choquenot et al. 1996; Taft 1999). Feral hogs possess the highest reproductive potential of any large mammal in North America (Wood and Barrett 1979; Hellgren 1999). Control of this animal is by shooting or trapping. Trapping, followed by euthanasia, is one of the most popular and effective methods of reducing population density (West et al. 2009). When used with bait, large portable corral traps can be very effective and practical.

Nutria (*Myocastor coypus*) is a highly prolific, large aquatic rodent introduced from South America. In many coastal marshes their large numbers have become a severe problem, because they eat vegetation, including the roots that hold the marsh together. High densities of nutria can result in the conversion of marsh to open water. Nutria also dig holes in levees, causing infrastructure problems. Although alligators prey on nutria, they are unable to significantly affect their population. Shooting and trapping can be used to control nutria numbers in localized areas.

The following are potential strategies for controlling nutria and swine on the refuge. All control methods discussed are authorized by 50 CFR 31.14.

- Participate in the Louisiana Coastwide Nutria Control Program (CNCP), and partner with local trappers to reduce nutria and hog populations. Under the CNCP, licensed trappers enrolled in the LDWF program shall be permitted to take nutria by trapping only, within designated management units. This has proven to be a cost-effective means to reduce nutria populations on both public and private lands in Louisiana (Coastwide Nutria Control Program, CWPPRA LA-03b).
- Manage nutria and hog populations through a combination of shooting and trapping, using qualified refuge personnel. The target for nutria control will be eradication. The target for hogs will be eradication, and subsequently to maintain the population at the lowest possible level. If eradication appears to be successful, surveys should continue in case estimates were low or to detect immigration.

- Contract an intensive nutria control program through USDA or a private contractor, potentially using traps, dogs, GPS tracking systems, and/or gunning. A combination of methods may be used through an intensive program using trained personnel to eradicate or significantly reduce the nutria population on the refuge (Jojola et al. 2005). However, this is a very expensive program, and given the current population status across the Gulf region, results of the program would be temporary. Therefore, this program may not be cost-effective.

- Contract an intensive feral hog control program through USDA, potentially using aerial gunning, GPS tracking system, and/or dogs. A combination of trapping, shooting, and the use of dogs to control hog populations can be highly effective (McCann and Garcelon 2008). In Texas, helicopters are the primary aircraft used for aerial control of feral hogs. This is a very selective method, and depredation problems can be stopped quickly. Large numbers of feral hogs can be taken in a single aerial control operation (Saunders and Bryant 1987). However, effects of disturbance to migratory and nesting waterbirds would need to be evaluated prior to implementation. Habitat types at Bayou Teche NWR are not generally conducive to successful aerial gunning because of the presence of closed-canopy forest.

- Open the refuge to public hunting of feral hogs. Public hunting on national wildlife refuges, state wildlife management areas, and private lands has been a time honored method of attempting to control feral hogs throughout the United States. However, this tool usually needs to be used in conjunction with other tools to effectively reduce numbers and to achieve long-term eradication of feral hogs within a given geographical area (Bieber and Ruf 2005). A "Refuge Opening Hunt Package," including a hunt plan, compatibility determination, and the proper NEPA documentation, would be needed. Because of incompatibility with black bear management (i.e., the likelihood that hunters will mistake bears for hogs), this strategy will not be used on Bayou Teche NWR.

MANAGEMENT STRATEGY PRESCRIPTIONS

To meet Habitat Management Objective 3.1, the following strategies will be used to control nutria and feral hog populations:

- Conduct yearly evaluations of nutria and feral hog populations on refuge lands, using established monitoring protocols.
- Feral hogs and nutria will be removed by refuge personnel as needed.
- Partner with area trappers to reduce nutria and feral hog populations.
- Participate in the State of Louisiana Nutria Control program by actively promoting the program and seeking assistance from area trappers to reduce nutria populations on refuge lands consistent with the state's Nuisance Animal Control Plan.

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Appendix B: Authors and Contributors

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Appendix C: Listed, Candidate, and Recovered Species Known to Occur on Bayou Teche National Wildlife Refuge

Group	Name	Population	Status
Birds	**Bald Eagle** (*Haliaeetus leucocephalus*)	U.S.A. conterminous states	Recovery
Mammals	**Louisiana black bear** (*Ursus americanus luteolus*)	Wherever found	Threatened

Appendix D: Factors Affecting Refuge Habitats

CLIMATE CHANGE

Anthropogenic climate change is causing increases in global average land and ocean temperatures (Bedoya et al. 2008). This warming trend is likely to cause substantial impacts to precipitation levels, sea level, ocean currents, species, and ecosystems (U.S. Fish and Wildlife Service 2010; Walther et al. 2002). The Southeast Region may be one of the most vulnerable regions in the United States to climate change mainly due to its high biodiversity and long, low-lying coastline (Smith 2004; Karl et al. 2009).

In the Southeast Region, the increase in average temperature is expected to continue with the greatest increases occurring in summer. The magnitude of rise is expected to be between 4.5° and 9° Fahrenheit by 2100, along with an increase in frequency of very hot days (Titus et al. 2009; U.S. Congressional Budget Office 2009). The number of freezing days for most of the Southeast has declined by 4 to 7 days per year since the mid-1970s (Karl et al. 2009).

Seasonal precipitation is also changing dramatically in this region. Fall precipitation over most of the region is up about 30 percent, with only a small decrease in south Florida (Karl et al. 2009). Summer precipitation has decreased in most areas of the Southeast, and during the past three decades there have been several severe droughts. Across the region the proportion of precipitation that falls in high-intensity storms has increased. High intensity storms cause an increased chance of flooding (Karl et al. 2009).

Currently, climate change is not the most important driver of changes in biodiversity; however, it could be the largest driver by the end of the 21st Century (Millenium Ecosystem Assessment 2005). Even so, there have already been measurable changes in global biodiversity due to climate change, particularly with regard to changes in species distributions, population sizes, timing of reproduction or migration events, and increases in the frequency of pest and disease outbreaks (Millenium Ecosystem Assessment 2005; Janetos et al. 2008; Walther et al. 2002). In the United States, climate change has already impacted terrestrial ecosystems by changing the timing and length of growing season, phenology, and species distributions and diversity (Janetos et al. 2008). In some cases, warming climate conditions have been shown to cause increases in density and cover of exotic species from warmer areas (Walther et al. 2002).

As climate change disrupts ecological processes with increasing severity, the Refuge System is likely to experience significant changes in its physical and biological resources. Regional Climate Science Centers are being established by the Department of the Interior. These centers will provide scientific information, tools, and techniques needed to manage land, water, wildlife, and cultural resources in the face of climate change. The U.S. Geological Survey and the Department of the Interior centers will also work closely with a network of Landscape Conservation Cooperatives in which federal, state, tribal, and other managers and scientists will develop conservation, adaptation, and mitigation strategies for dealing with the impacts of climate change (U.S. Geological Survey 2011; U.S. Fish and Wildlife Service 2010).

Climate change effects which can be expected on Bayou Teche NWR include increased temperatures, increasing fall precipitation coupled with decreased summer precipitation, increased frequency and severity of droughts, increased intensity of hurricanes with possible increased frequency as well, and rising sea level. Local subsidence will exacerbate the effects of global sea level rise on southern Louisiana. Management of the refuges will certainly be affected by these changes, though the details are uncertain. Some likely scenarios, however, include the following:

- Increased temperatures and concomitant decreases in severity of cold weather may lead to changes in species composition, including increases in tropical and subtropical exotic invasives such as water hyacinth, giant salvinia, tallowtree, and nutria. Additional management actions may be required to control these species in this case.
- If seasonal precipitation distribution in south Louisiana becomes more uneven, salinity fluctuation in marsh and tidal swamp habitat may be wider, leading to changes in plant and animal communities and further loss of organic soil through oxidation.
- More intense tropical storms will lead to recurring impacts similar to that experienced from recent hurricanes—conversion of marsh to open water, and damage to refuge infrastructure.
- Rising global sea level, combined with local subsidence caused by geologic forces, will lead to changes in relative sea level. Since most of the refuge lies below 5 feet in elevation, rising sea level will lead to conversion of unprotected refuge habitats to brackish or saline marsh, and even to open water.
- Changes in temperature and precipitation regimes will have unpredictable effects on habitats and species, including resources of concern and their food resources.

LANDSCAPE CONTEXT

Bayou Teche NWR lies in a heavily fragmented landscape, surrounded by agricultural fields on natural levees of Bayou Teche and its distributaries and by swamp and marsh habitat crisscrossed by canals, pipelines, and levees. Habitat fragmentation occurs when large blocks of continuous habitat are broken up into smaller blocks by the creation of breaks consisting of different kinds of habitat. Habitat fragmentation is usually a consequence of habitat conversion, but its effects are distinct, and the difference is important to restoration efforts. In bottomland hardwood systems, fragmentation can result from human activities including construction of roads and other rights-of-way, forest management which incorporates clear-cutting, conversion to agriculture or other, non-forest uses, and engineered hydrologic management structures such as levees and ditches. Fragmentation affects ecosystem structure and function in a number of ways, and the effects depend on the pattern and spatial properties of the remaining fragments, as well as their size. For example, blocks of forest which are separated by a road or pipeline right-of-way may retain much of their shared function as habitat for wide-ranging species which are able to cross short distances of inhospitable habitat, while similar-sized blocks that are separated by large distances may effectively isolate those same wide-ranging species. However, species composition or other elements of ecosystem structure may change as a result of the presence of a corridor of open habitat, even if the total size of the habitat block does not appreciably change. Species which are adapted to ecotones and open habitat will have access to the interior of a previously inhospitable (to them) area, and the total area of forest interior habitat (i.e., that which is more than some minimum distance from edges) will decrease by much more than the area converted.

Habitat fragmentation can result in decline or loss of wide-ranging and interior-dependent species (U.S. Fish and Wildlife Service 1995); increased invasion by exotic plants and animals; decreased (or increased) species diversity (Rudis 1995); and changes in predator, parasite, and pathogen populations and effects. On Bayou Teche NWR, fragmentation negatively affects Louisiana black bear recovery by isolating bear populations and necessitating travel across roads, which results in vehicle-strike mortality. Habitat restoration in existing habitat breaks, constructed crossing areas for roads, and wildlife-oriented forest management can mitigate the effects of habitat fragmentation on Louisiana black bears (LMVJV Forest Resource Conservation Working Group 2007).

Appendix E: Soils

All information taken from (USDA Natural Resources Conservation Service 2012)

Map Unit Symbol	Map Unit Classification	Brief Description	Management Information
ATB	Aquents, dredged, 1 to 5 percent slopes, occasionally flooded	N/A	N/A
BdA	Baldwin silty clay loam, 0 to 1 percent slopes; Fine, smectitic, hyperthermic Chromic Vertic Epiaqualfs	This level, poorly drained, very slowly permeable soil is on alluvial plains. It has a loamy surface layer and clayey and loamy subsoil. Natural fertility is high. The shrink-swell potential is high. The soil has a seasonal high-water table in winter and spring.	These are wet, clayey soils with a high potential for productivity. Equipment limitations and seedling mortality are severe. This is due primarily to excess water. Silvicultural operations should be restricted to dry weather periods. Only tree species adapted to wet clay soils should be planted. Plant more seedlings than the recommended rate on these soils to ensure a stand. Site index for green ash is 80, cottonwood 100, oaks and sweetgum 90.

Map Unit Symbol	Map Unit Classification	Brief Description	Management Information
BRA	Barbary muck, frequently flooded; Fine, smectitic, hyperthermic Chromic Vertic Epiaqualfs	The Barbary component makes up 85 percent of the map unit. Slopes are 0 to 1 percent. This component is on swamps on delta plains. The parent material consists of fluid clayey alluvium. Depth to a root restrictive layer is greater than 60 inches. The natural drainage class is very poorly drained. Water movement in the most restrictive layer is very low. Available water to a depth of 60 inches is very high. Shrink-swell potential is low. This soil is frequently flooded. It is frequently ponded. A seasonal zone of water saturation is at 0 inches throughout the year. Organic matter content in the surface horizon is about 50 percent. Non-irrigated land capability classification is 8w. This soil meets hydric criteria.	
DP	Dumps	N/A	N/A
GaA	Galvez silt loam, 0 to 1 percent slopes; Fine-silty, mixed, superactive, hyperthermic Aeric Endoaqualfs	This soil is level and somewhat poorly drained. It is on natural levees on alluvial plains. The soil is loamy throughout. It has a seasonal high water table in winter and spring. Natural fertility is medium.	Soils in this group are moderately wet, loamy and clayey with a high potential for productivity. Equipment limitations are moderate and seedling mortality is slight to moderate. This is due primarily to excess water. These soils are best suited for southern hardwood. Site index for green ash is 80, cottonwood 110, oaks and sweetgum 90.

Map Unit Symbol	Map Unit Classification	Brief Description	Management Information
HSA	Harahan and Allemands soils, drained; Allemands: Clayey, smectitic, euic, hyperthermic Terric Haplosaprists; Harahan: Very-fine, smectitic, nonacid, hyperthermic Vertic Endoaquepts	Level, very poorly drained and poorly drained soils that have a clayey or mucky surface layer and clayey or mucky subsoil in former swamps. The soils in this map unit are in former swamps that are protected from most floods by levees and are drained by pumps. Flooding is rare, but it can occur during severe storms or when levees or pumps fail. Elevation ranges from sea level to about 3 feet below sea level. Slopes are 0 to 1 percent. The Harahan soils are level, poorly drained, and are very slowly permeable to impermeable. They have a dark gray, firm clay surface layer; a gray non-fluid clay subsoil; and a substratum of gray, very fluid clay in the upper part and greenish gray very fluid clay in the lower part. The Allemands soils are level, very poorly drained, and are very slowly permeable to impermeable. They have a dark brown muck surface layer. The underlying material is very dark muck in the upper part, gray clay in the middle part, and dark gray clay in the lower part.	

Map Unit Symbol	Map Unit Classification	Brief Description	Management Information
IbA	Iberia clay, 0 to 1 percent slopes; Very-fine, smectitic, hyperthermic Typic Epiaquerts	This nearly level, poorly drained soil is in broad areas on the alluvial plain. It formed in alluvium; and it has a clayey surface layer and subsoil. The soil is neutral to moderately alkaline in the upper 20 inches of the profile. Natural fertility is high. This soil has a darker surface layer that contains more organic matter than most other soils in the parish. Surface runoff is very slow. Water and air move very slowly through the soil. Flooding is rare, but it can occur during unusually wet periods. A seasonal high water table is within 2 feet of the soil surface for long periods during December through April. This soil has a very high shrink-swell potential. Slopes are less than 1 percent.	This nearly level, poorly drained soil is in broad areas on the alluvial plain. It formed in alluvium; and it has a clayey surface layer and subsoil. The soil is neutral to moderately alkaline in the upper 20 inches of the profile. Natural fertility is high. This soil has a darker surface layer that contains more organic matter than most other soils in the parish. Surface runoff is very slow. Water and air move very slowly through the soil. Flooding is rare, but it can occur during unusually wet periods. A seasonal high water table is within 2 feet of the soil surface for long periods during December through April. This soil has a very high shrink-swell potential. Slopes are less than 1 percent.

Map Unit Symbol	Map Unit Classification	Brief Description	Management Information
IEA	Iberia clay, frequently flooded; Very-fine, smectitic, hyperthermic Typic Epiaquerts	This level, poorly drained or somewhat poorly drained soil is at low elevations on the alluvial plain. It is flooded frequently for very long periods. This soil is clayey throughout or it has a loamy surface layer and clayey subsoil. Natural fertility is high. Surface runoff is very slow. Water and air move very slowly through the soil. The seasonal high water table is near the soil surface. This soil has a very high shrink-swell potential. Slopes are less than 1 percent.	Soils in this group are wet, frequently flooded clayey soils with a moderately high potential for productivity. Equipment limitations and seedling mortality are severe due primarily to excess water. These soils are best suited for bottomland hardwoods. Silvicultural operations should be restricted to dry weather periods and more seedlings than the recommended rate should be planted to ensure a stand. Site index for green ash is 70, cottonwood 90, oaks and sweetgum is 80.
KEA	Kenner muck, very frequently flooded; Euic, hyperthermic Fluvaquentic Haplosaprists	The soils in this map unit are in freshwater marshes (Figure 3) that are flooded or ponded most of the time. Elevation ranges from sea level to about 1 foot above sea level. Slopes are 0 to 1 percent. Kenner soils are in broad basins. These soils are level, very poorly drained, and are very slowly permeable. They have a thick surface layer of dark gray muck and underlying material of dark brown muck in the upper part, gray clay in the middle part, and very dark gray muck in the lower part.	

Map Unit Symbol	Map Unit Classification	Brief Description	Management Information
LoA	Loreauville silt loam, 0 to 1 percent slopes; Fine-silty, mixed, superactive, hyperthermic Mollic Endoaqualfs	This level, somewhat poorly drained soil is in high positions on natural levees of streams and former streams. The soil has a silt loam surface layer and silty clay loam subsoil. It has medium-to-high natural fertility. Water runs slowly off the surface, and it moves through the soil at a moderately slow rate. A seasonal high water table is in the soil for long periods in winter and spring. The shrink-swell potential is moderate in the subsoil.	These are moderately wet, loamy soils with a very high potential for productivity. Equipment limitations are moderate due primarily to excess water. These soils are best suited for southern hardwoods. Site index for green ash is 80-100, cottonwood 100-120, oaks 90-110, and sweetgum 110.
MAA	Maurepas muck, frequently flooded; Euic, hyperthermic Typic Haplosaprists	This is a level, very poorly drained, very fluid organic soil in swamps. It is ponded or flooded most of the time. Typically, the soil is very fluid muck throughout. It has a low capacity to support loads. The total subsidence potential is very high. The shrink-swell potential is low.	The natural vegetation consists of water-tolerant trees, such as baldcypress and water tupelo, and aquatic understory plants, such as alligatorweed and duckweed.

Map Unit Symbol	Map Unit Classification	Brief Description	Management Information
ShA	Schriever clay, 0 to 1 percent slopes; Very-fine, smectitic, hyperthermic Chromic Epiaquerts	This nearly level, poorly drained soil is on broad flats on the alluvial plain. It is clayey throughout. Natural fertility is medium or high. Runoff is slow or very slow. Water and air move very slowly through the soil. The shrink-swell potential is high or very high. A seasonal high water table is within 2 feet of the soil surface during December through April. Flooding is rare, but it can occur during unusually wet periods. Slopes are less than 1 percent.	These are wet, clayey soils with a high potential for productivity. Equipment limitations and seedling mortality are severe. This is due primarily to excess water. Silvicultural operations should be restricted to dry weather periods. Only tree species adapted to wet clay soils should be planted. Plant more seedlings than the recommended rate on these soils to ensure a stand. Site index for green ash is 80, cottonwood 100, oaks and sweetgum 90.
SlA	Schriever clay, frequently flooded; Very-fine, smectitic, hyperthermic Chromic Epiaquerts	This nearly level, poorly drained soil is on broad flats on the alluvial plain. It is clayey throughout. Natural fertility is medium or high. Runoff is slow or very slow. Water and air move very slowly through the soil. The shrink-swell potential is high or very high. A seasonal high water table is within 2 feet of the soil surface during December through April. Flooding is rare, but it can occur during unusually wet periods. Slopes are less than 1 percent.	These are wet, clayey soils with a high potential for productivity. Equipment limitations and seedling mortality are severe. This is due primarily to excess water. Silvicultural operations should be restricted to dry weather periods. Only tree species adapted to wet clay soils should be planted. Plant more seedlings than the recommended rate on these soils to ensure a stand. Site index for green ash is 80, cottonwood 100, oaks and sweetgum 90.
UD	Udorthents, 1 to 20 percent slopes; Entisols	N/A	N/A
W	Water	N/A	N/A

Figure E1. Soil mapping units on Franklin Unit, Bayou Teche NWR

Figure E2. Soil mapping units on Centerville Unit, Bayou Teche NWR
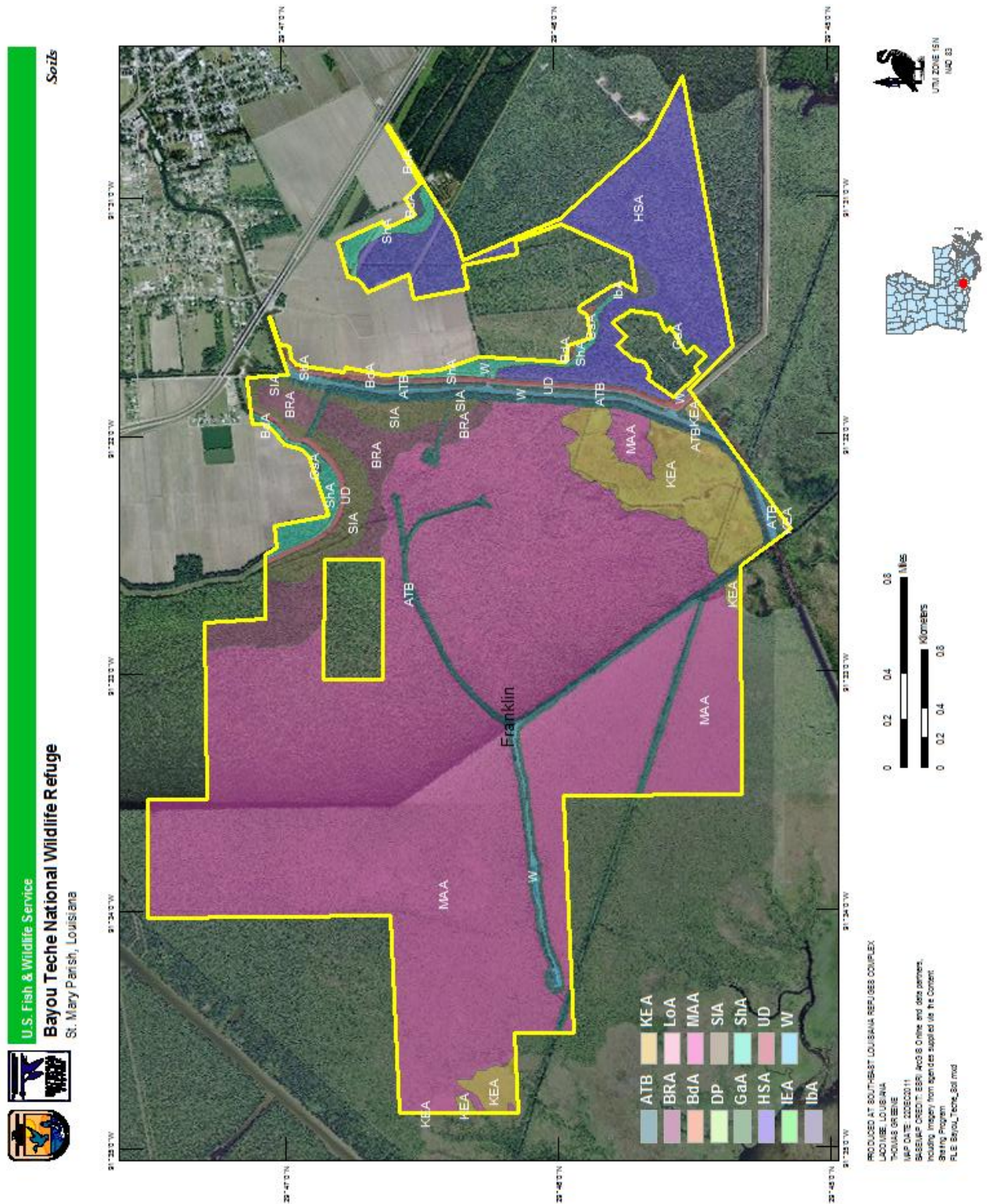
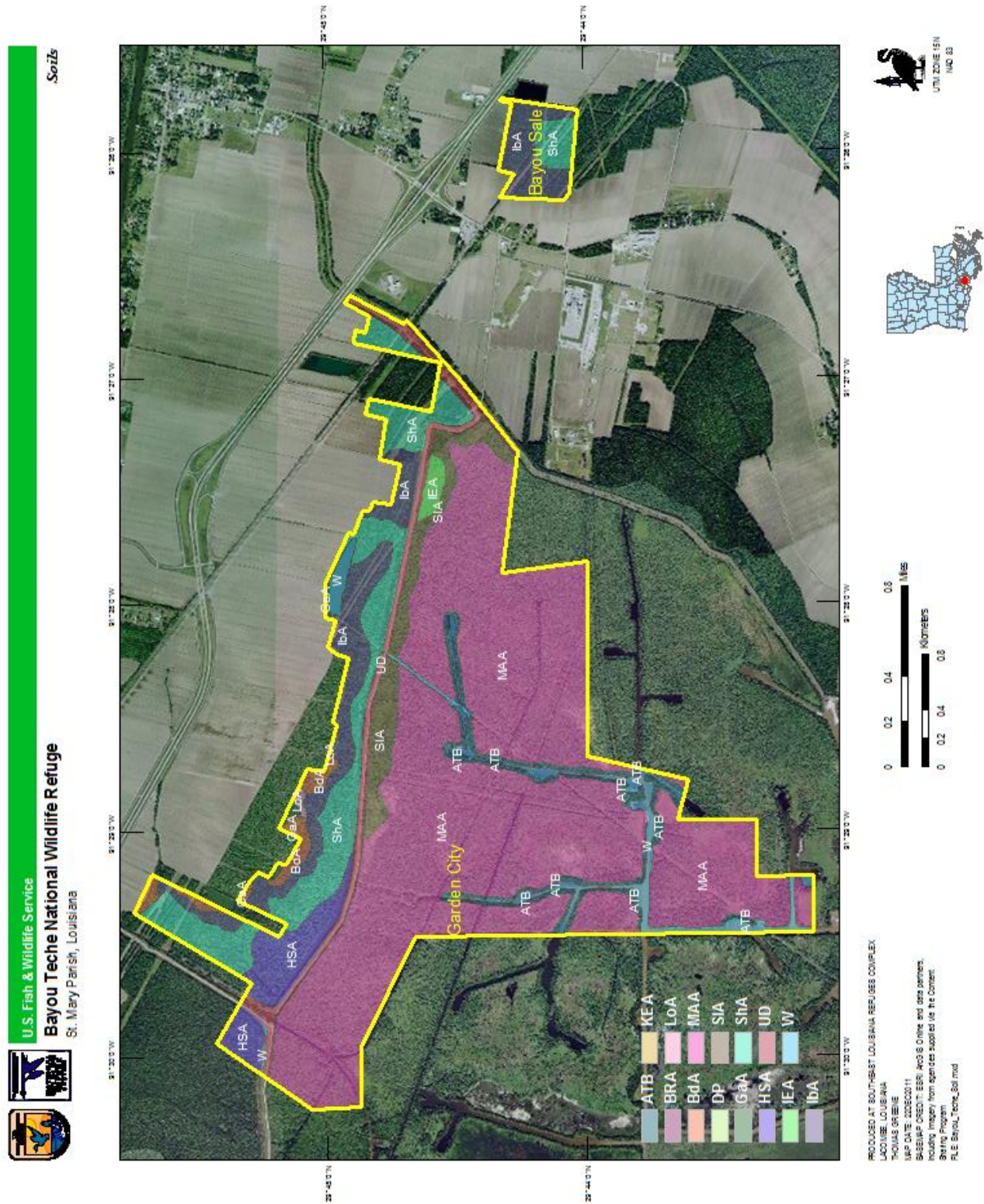**Figure E3. Soil mapping units on Garden City and Bayou Salé Units, Bayou Teche NWR**
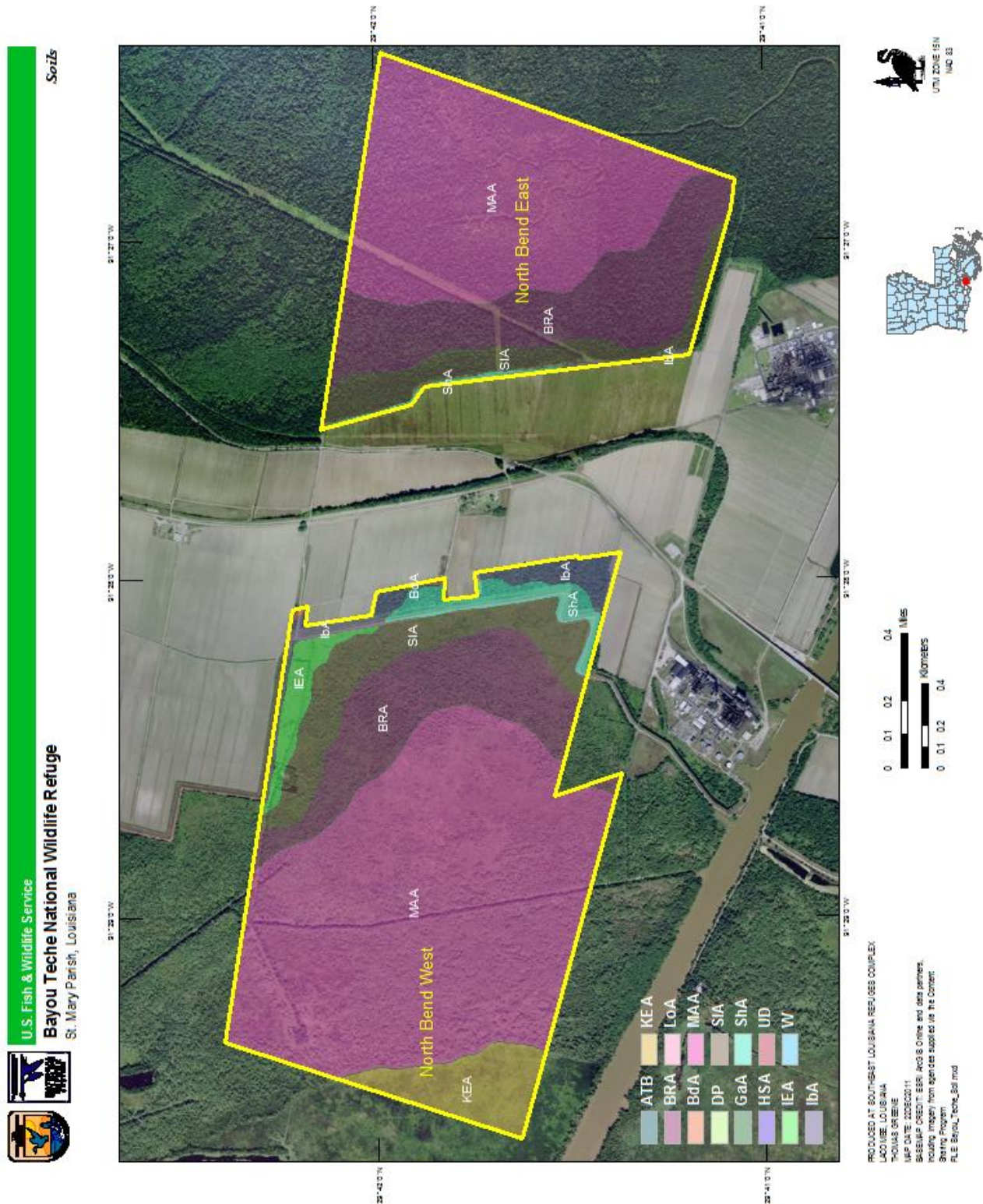
Figure E4. Soil mapping units on North Bend East and West Units, Bayou Teche NWR

Appendix F. Environmental Action Statement

U. S. FISH AND WILDLIFE SERVICE
ENVIRONMENTAL ACTION STATEMENT FOR CATEGORICAL EXCLUSION

Within the spirit and intent of the Council on Environmental Quality's regulations for implementing the National Environmental Policy Act (NEPA), and other statutes, orders, and policies that protect fish and wildlife resources, I have established the following administrative record and determined that the following proposed action is categorically excluded from NEPA documentation requirements, consistent with 40 CFR 1508.4, 516 DM 2.3A, 516 DM 2 Appendix 1, and 516 DM 6 Appendix 1.4.

Proposed Action and Alternatives

The proposed action is the approval and implementation of the Habitat Management Plan (HMP) for Bayou Teche National Wildlife Refuge (NWR). This plan is a step-down management plan providing the refuge manager with specific guidance for implementing goals, objectives, and strategies identified in the Comprehensive Conservation Plan (CCP) for Bayou Teche National Wildlife Refuge (U.S. Fish and Wildlife Service 2009).

The proposed CCP action was the preferred alternative among three alternatives considered in the Draft Environmental Assessment (EA) (U.S. Fish and Wildlife Service 2009). The preferred action in the CCP was to restore and improve ecological diversity and augment visitor services. Implementing the preferred alternative will result in the restoration and improvement of refuge resources needed for wildlife and habitat management, while providing opportunities for a variety of additional compatible wildlife-dependent recreation, education, and interpretive activities. The preferred alternative will also allow the refuge to provide law enforcement protection that adequately meets the demands of an urban environment.

The CCP has defined goals, objectives, and strategies to achieve the stated action. The actions further detailed in the HMP have been identified, addressed, and authorized by the CCP for Bayou Teche NWR.

The following strategies will be used to manage bottomland hardwood forest habitat in the Franklin, Garden City, and North Bend East Units, to achieve the objectives listed in Section 4.1:

- Stand entry will be prioritized according to Table 4. The order of entry schedules a stewardship review for each unit with the intention of assessing the current conditions and developing a habitat management prescription which best achieves the habitat management objectives. Each unit will be cruised to assess timber volume and value and habitat parameters including mast, cover, and den trees. Operability will be assessed based on soil type and road infrastructure. This "order of entry" schedule considers the timing of past habitat management actions and the recovery time necessary for leave trees to respond to the silvicultural treatments before the next entry is scheduled. The schedule also considers the

temporary disturbance of a logging operation and distributes these effects across the refuge landscape over at least a 10-year period. This allows the trees time to respond to the silvicultural action, reduces local area effects, and allows wildlife an adequate cycle of benefit from the improved habitat.

Table 4. Forested management unit order of entry with approximate acreage to be inventoried and priority number

Management Unit	Forested Acreage*	Priority**
Franklin	437	1
North Bend East	533	2
Garden City	502	3

*Not including spoil banks and other small, isolated areas not considered operable.
**Priority based on importance of unit to Louisiana black bear, as evidenced by current use and potential contribution to habitat.*

- Prescribed treatments will be applied no more than once every 10 years on the same acreage. All data collected and other records will be based on management units shown in Figure 2. If a unit is reviewed, and it is determined that no active management is necessary, the next unit in the order of entry may be selected until a suitable unit requiring treatment is found. Because there are three units with potentially manageable forest, reviews will be scheduled every 3 or 4 years. Administrative units may be subdivided during the prescription process if necessary, allowing treatments to proceed on portions of a unit.

- Forest management prescriptions will be written for hardwood forest blocks which follow guidelines in (LMVJV Forest Resource Conservation Working Group 2007) for bottomland hardwood forest desired conditions, with special emphasis on the Louisiana black bear.

Summary of forest management process:

- Unit is selected based on priority in Table 4.
- Stewardship review is conducted for unit, including cruise and assessment of relevant variables related to silvicultural manipulation.
- If silvicultural treatment is needed, a habitat management prescription will be written for the unit.
- After approval is obtained for the prescription, it is carried out.
- Effects are monitored over time to measure progress toward objectives.
- Under ordinary circumstances, subsequent stand entry is precluded for 10 years after treatment is complete.

The following strategies have been selected for controlling invasive exotic plants on Bayou Teche NWR:

- Chinese tallow will be controlled on spoil banks along canals and remnant road beds in the Franklin, Garden City, North Bend West, and Centerville Units by application of Garlon 4 as a basal spray in diesel, or by other herbicide treatment as approved. Treatment will be prioritized according to the importance of the habitat for the Louisiana black bear and the potential for releasing native vegetation valuable for bear habitat, including oaks and other mast-producing species.
- The refuge will work with partners (LSU, LDWF) to release *Cyrtobagous salviniae* in salvinia-infested units of Bayou Teche NWR. Timing will depend on the success of the recent release at Mandalay NWR. If that release is deemed successful based on significant reduction in cover of salvinia on the refuge, releases will be conducted on Bayou Teche NWR by 2014.
- Infestations of water hyacinth, Cuban sedge, and other aquatic weeds will be managed by herbicide treatment when they pose a threat to habitat or human use by preventing access. Herbicides to be used in this effort may include 2,4-D, diquat, glyphosate, as well as other herbicides which are labeled and approved. All herbicides will be approved through the Pesticide Use Proposal process and will follow Integrated Pest Management Policy (569 FW 1). An up-to-date list of approved herbicides is kept on file at the refuge complex office.

To meet Habitat Management Plan Objective 3.1, the following strategies will be used to control nutria and feral hog populations:

- Conduct yearly evaluations of nutria and feral hog populations on refuge lands, using established monitoring protocols.
- Feral hogs and nutria will be removed by refuge personnel as needed.
- Partner with area trappers to reduce nutria and feral hog populations.
- Participate in the State of Louisiana Nutria Control program by actively promoting the program and seeking assistance from area trappers to reduce nutria populations on refuge lands consistent with the state's Nuisance Animal Control Plan.

Categorical Exclusions

Categorical Exclusion Departmental Manual 516 DM 6, Appendix 1, Section 1.4 B (10), which states "the issuance of new or revised site, unit, or activity-specific management plans for public use, land use, or other management activities when only minor changes are planned. Examples could include an amended public use plan or fire management plan, if applicable to implementation of the proposed action.

Consistent with Categorical Exclusion (516 DM 6, Appendix 1, Section 1.4 B (10)) the HMP is a step-down management plan which provides guidance for implementation of the general goals, objectives, and strategies established in the CCP, serving to further refine those components of the CPP specific to habitat management. This HMP does not trigger an Exception to the Categorical Exclusions listed in 516 DM 2, Appendix 2.

Minor changes or refinements to the CCP in this activity-specific management plan include:

- Habitat management objectives are further refined by providing numerical parameter values that more clearly define the originating objective statement.
- Habitat management objectives are restated so as to combine appropriate objectives or to split complicated objectives for improved clarity in the context of the HMP.
- Specific habitat management guidance, strategies, and implementation schedules to meet the CCP goals and objectives are included (e.g., location, timing, frequency, and intensity of application).
- All details are consistent with the CCP and serve to provide the further detail necessary to guide the refuge in application of the intended strategies for the purpose of meeting the habitat objectives.

Permits/Approvals

Intra-Service Section 7 Consultation (Endangered Species Act) was conducted during the comprehensive conservation planning process for Bayou Teche NWR.

The management action will result in the implementation of the preferred alternative developed during the preparation of the CCP for Bayou Teche NWR, a 9,028-acre refuge in St. Mary Parish, Louisiana. Approval and subsequent implementation of the CCP directs management actions on the refuge for the next 15 years. The preferred alternative identified for the CCP is to maximize the quality and quantity of habitat for threatened and endangered species and wintering waterfowl by focusing on a more adaptive management approach through improved biological monitoring. This management action supports the purpose for which the refuge was established, "to conserve (A) fish and wildlife which are listed as endangered species or threatened species or (B) plants" 16 U.S.C. 1534 (Endangered Species Act of 1973). The CCP identifies four broad goals for habitat, wildlife, people, and cultural resources, and describes specific objectives for each of the goals. Detailed strategies are also outlined. The goals and objectives were developed to support regional and national plans and initiatives and in partnership with others such as the Louisiana Department of Wildlife and Fisheries.

In addition to the specific purposes established for the refuge, the Improvement Act provides clear guidance for the mission of the Refuge System and priority wildlife-dependent public uses. The Act states that each refuge will:

- Fulfill the mission of the National Wildlife Refuge System;
- Fulfill the individual purposes of each refuge;
- Consider the needs of wildlife first;

- Fulfill requirements of comprehensive conservation plans that are prepared for each unit of the Refuge System;
- Maintain the biological integrity, diversity, and environmental health of the Refuge System; and
- Recognize that wildlife-dependent recreation activities, including hunting, fishing, wildlife observation, wildlife photography, and environmental education and interpretation are legitimate and priority public uses; and allow refuge managers authority to determine compatible public uses.

One listed species and designated critical habitat for that species were found at Bayou Teche NWR–the threatened Louisiana black bear (*Ursus americanus luteolus)*. The determination was a concurrence that "Current management and public use are not expected to adversely affect Louisiana black bears." In respect for the fact that threatened and endangered species (most specifically the Louisiana black bear) are the purpose of Bayou Teche NWR, time and space zoning will be used if necessary in order to meet refuge objectives. Strategies used to date have included closing hunting after November 30 in areas that have historically provided denning habitat for Louisiana black bears. Prohibiting the use of bait will minimize interactions between hunters and feeding bears.

Public Involvement/Interagency Coordination

Formal public involvement began with an open house held in April 2007 for the general public to give suggestions and comments regarding the future of the refuge. Announcements giving the location, date, and time for the scoping meeting appeared in local newspapers and were furnished to local residents. The scoping meeting was held in Franklin, Louisiana. Approximately 11 people attended the open discussion of the CCP process for the future management of Bayou Teche NWR. After orienting attendees to the CCP process, they could move freely among the following discussion areas: (1) Public programs and visitor facilities; (2) wildlife and habitat management; and (3) refuge administration. Each area offered information and a chance to make written and oral statements (Appendix D). Also, comment cards were available, which could be mailed to the refuge. Approximately 17 comments and questions were recorded for the Bayou Teche NWR meeting. Input obtained from the scoping meetings was used to develop the Draft CCP/EA. No major conflicts were declared in the comments received from the public. Initial planning began in May 2007 with a meeting of planning team members. Early in the process of developing this CCP, the planning team identified a list of issues and concerns that were likely to be associated with the conservation and management of Bayou Teche NWR based on the reviews and public scoping. A mailing list of the public, landowners, state and tribal agencies, non-profit organizations, local governments, and other interested stakeholders was initiated. Comments received are documented in the Bayou Teche National Wildlife Refuge Comprehensive Conservation Plan (USFWS 2009a).
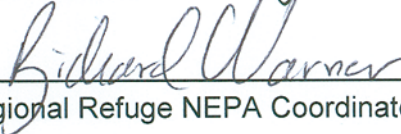
Supporting Documents

Supporting documents for this determination include relevant office file material and the following key references:

Bayou Teche NWR Draft Comprehensive Conservation Plan and Environmental Assessment (U.S. Fish and Wildlife Service 2009b) (Copy on file at Southeast Louisiana National Wildlife Refuge Complex Headquarters Office in Lacombe, Louisiana)

_____   12/3/12_____
Project Leader   date

_____   04/18/2013____
Regional Refuge NEPA Coordinator   date

Habitat Management Plan for
Bayou Teche National Wildlife Refuge

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